Chapter 1

For the readers - I have a life and I must tend to it, but I can sneak in every so often and contribute here. I hope others with AE experience can chime in and help out... but this thread is needed as our trucks age and more scan tools are purchased.

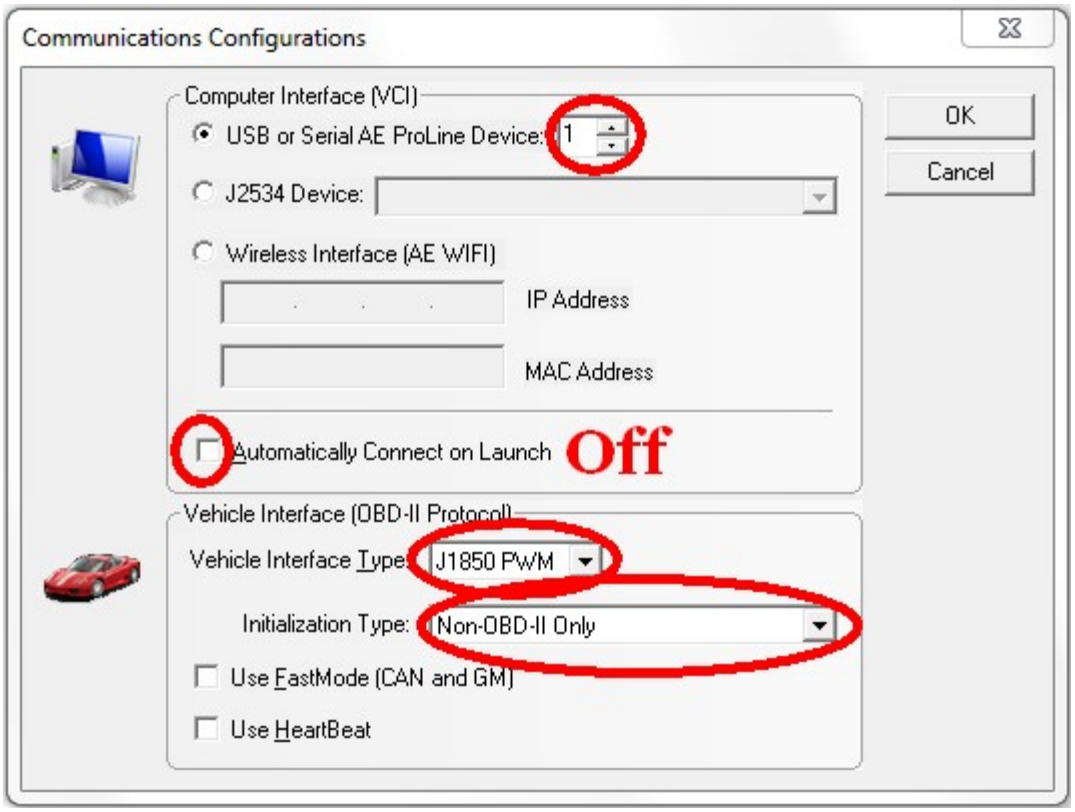
*****Critical edit: Powering your laptop from the cigarette lighter while using the USB-style OBDII interface has the potential to damage the interface and/or your laptop. Contact AutoEnginuity for input before powering your laptop from the vehicle.*****

I see threads where people have **AutoEnginuity** and other similar scan tools to look at the readings on their vehicles, but are unsure of what to look at and what it means when they look at it. There are readings in there that can reveal stuff a tuner would rather not share... like Fuel Injector Pulse Width, Mass Fuel Desired, and Injector Control Pressure combinations. To protect intellectual property, I will steer clear of using AE to reverse-engineer tunes. This is for troubleshooting our vehicles: Finding and resolving economy eviscerators, horsepower hijackers, start stealers, boost burglars, back pressure bloaters/pillagers, and sound spoilers.

Let's start with the most basic function – clearing the codes to make sure we are reading the news, not ancient history. Connection – Key On Engine Off (KOEO):

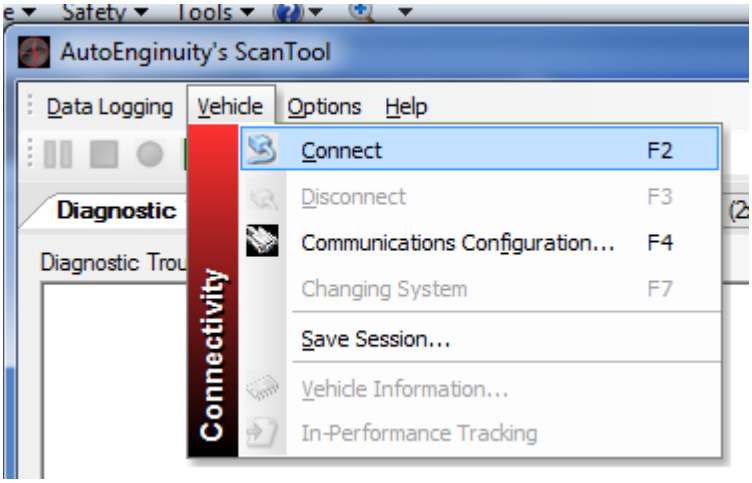
1. Open your AE software and have your cable/adaptor connected to the OBDII port and laptop. If you have a security dongle, make sure it is plugged in to one of the USB ports as well.

2. Click on “Vehicle” and set up your “Communications Configuration” for the software to work with our era of vehicle. There is no way for me to cover all the versions, so I'll just post an image of how I'm set up for the quickest connection.

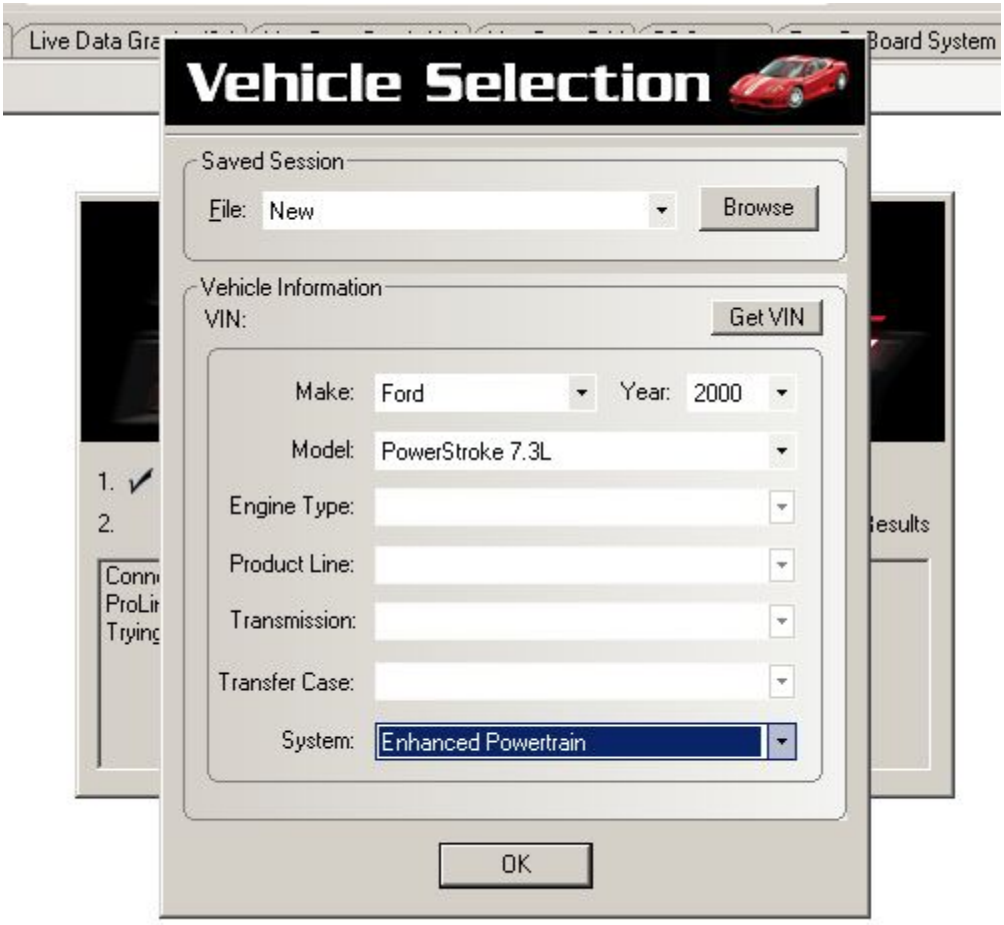


3. You need the key on to start a connection. Failure to have the key on will just give an error message when you try to connect, and some versions of AE require a restart of the software to clear the error.

4. Go to “Vehicle” on the menu and select “Connect”... or just press the “F2” key on your keyboard.



5. A window will pop up, showing the progress of the connection... then the “Vehicle Selection” window will pop up. Enter your Make, Year, and model... but I don't recommend messing with the VIN. I tried many combinations on my version of AE and it was a wasted effort. For this exercise, under “System:” - select Enhanced Powertrain. The “OK” button can use a good clickin' right about now.



6. Another window will pop up, asking if you want to poll all your trouble codes. I suggest “ALL” for the first connection.

You have just done the secret handshake thing and you've accessed the guts of your vehicle. Now you tread lightly until you learn what needs to be done in here. Not only can you read sensors, but you can control many things and set up test operations. I don't know if damage can be done, but I've never accidentally started a buzz test with the engine running... and I really don't want to try

it, nor do I suggest anybody else does.

The first screen up is the “Diagnostic Trouble Codes” screen. You will likely have a whole bunch of stuff in there from lack of resetting – but ignore those just for now. You'll say “But all these codes!” and I say things happen over time and the list in there gets weird without a good reset once in a while. By all means, write down all the codes (you can get descriptions from codes any other time) because you'll want to learn your vehicle. After you've recorded your DTC list, press the “Clear” button for all codes. Now we do an odd thing... we disconnect and repeat from step four... but don't clear the new codes that may pop up. You have just completed your first full function with AE.

I'm writing the next step – BARO, EBP, and MAP readings with KOEO. I'll post it when completed and time permits.

Chapter 2

matt9923 - I have condensed that post to make it easier to read. Great find!!

AutoEnginuity **Software Configuration** When you first launch the **AutoEnginuity** software there are some settings that need to be modified. The settings below are what we recommend to get the best results when connecting to Powerstroke Diesel vehicles. Connection to other vehicles may require changes to these settings. All of these settings are located in "Communications Configuration" on the "Vehicle" menu.

- Computer Interface:
  - Select "Auto Detect Serial Port" ONLY if you are using a Serial version of the **AutoEnginuity** tool
  - Select "USB or Manually Set Serial Port" for USB versions of the **AutoEnginuity** tool
  - I prefer to turn off "Automatically Connect on Launch" so I can start the software without it trying to connect
- Vehicle Interface (these settings are for the BEST connectivity support for FORD POWERSTROKE TRUCKS ONLY):
  - "Vehicle Interface Type" should be "J1850PWM" for a 7.3L and "Auto-Detect" for a 6.0L
  - "Initialization Type" should be "Non-OBDII" when connecting to a 7.3L
    NOTE: The above settings will need to be changed to "Auto-Detect" and "OBDII Compliant" if connecting to a non-Powerstroke vehicle
  - "Use Fastmode CAN" and "Use Heartbeat" should not be selected when connecting to a Ford
- The above settings are automatically saved. You won't need to adjust these unless you change them to connect to a different vehicle.

Cylinder Contribution Testing (7.3L) **AutoEnginuity** can be used to execute Cylinder Contribution Tests (CCT) on 94-03 7.3L Powerstroke Diesel equipped vehicles (the 6.0L PCM doesn't have this functionalilty built-in). A common cause of failed CCTs is "EOT out of Range"...which means Engine Oil Temperature is out of range. The following approximate EOT values are required to execute a CCT:

- 94-97 Powerstroke Diesel: 170°F+
- 99-03 Powerstroke Diesel: 135°F+
- Also, make sure that ALL accessories are turned off (A/C, etc.)

Note: on 94-97 Powerstroke Trucks, you may be able to audibly hear the test turning cylinders on and off (trucks with newer calibrations should complete 3 test cycles). The test will be terminated early if a cylinder is found to be very bad. Once that cylinder is repaired, the CCT will need to be run again to check the rest of the cylinders. You will not hear this on the 99-03 Powerstroke Trucks as the test is performed differently. There is also a potential problem with the CCT if it detects an issue with either the #6 or #8 cylinder. Due to the fact that cylinders #6 and #8 fire in sequence and are physically adjacent to each other in the engine, it is not uncommon for a CCT to mis-report a problem with one cylinder that actually exists in the other.

For 99-03 7.3L, another way to use **AutoEnginuity** to see if there are problems with a particular cylinder is to monitor the "Cylinder x Change Rotational Vel" or "Percentage of Crank Deceleration" PID (also commonly called PERDEL). This PID exists for all 8 cylinders and is a representation of crankshaft velocity change (decrease) at the time the cylinder is firing. Ideally, these should all read 0%.

Any cylinder consistently reading more than 3-5% change in rotational velocity is suspect and should be further examined. Note: Engine should be fully warmed up before checking PERDEL data.

7.3L Injector "Buzz" Test The Injector "Buzz" Test can be used to look for a faulty fuel injector. It is best to run this test on a totally cold engine, one that has sat overnight and has not been started. Initiate the "Buzz" test and then listen carefully to the injectors as the test is completed. First, all 8 injectors will "Buzz" at the same time. Then, the IDM will "Buzz" the injectors in numerical order (1, 2, 3, 4, 5, 6, 7, 8). Remember that cylinders 1-3-5-7 are on the passenger side and 2-4-6-8 are on the drivers side, with cylinders 1 & 2 being at the front of the engine. You should hear a strong "Buzz" bouncing from side to side for all 8 injectors. If one of the injectors doesn't "Buzz", you've found a problem cylinder. It is important to note that when an injector fails to "Buzz" properly, you will still hear the other 7 injectors make a faint buzz...this is a designed function to protect the IDM.
Note: Because the IDM will "buzz" the other 7 injectors faintly during individual cylinder tests, it is possible for the "Buzz" test to report no problems detected. If the "Buzz" test reports no failures, but you don't hear a particular cylinder "Buzz"...more than likely there is a problem with that injector.
It should also be noted that an injector failing a "Buzz" test can have many causes. The injector can be in a failed state (loose armature plate screw, bad solenoid, etc.), the UCV (under valve cover) gasket or harness could be damaged or disconnected, the main engine harness could be damaged or the IDM could be damaged. Further inspection will be necessary to determine the actual problem...but at least you now have a place to start.

Quick KOEO Sensor Checks: There are a few sensors that can be easily checked with a scantool. Starting with a "Dead Cold" engine (let it sit overnight, don't start), connect to the truck with the ScanTool. Check the following:

1. Oil Temp should closely match the current Ambient Temp.
2. Readings for Exhaust Backpressure, Manifold Absolute Pressure and Barometric Pressure should all be within 1/2 psi of each other (this should be true with the engine either warm or cold).

(Note: with the engine running, MAP and EBP values are "Pressure + Baro". For example, if Baro is 14.7 and there is 2psi of boost, MAP will read 16.7. Also, there is a calculated PID called "Manifold Gauge Pressure" that doesn't have the Baro pressure added in).

KOER (Key On Engine Running) On-Demand Test: On the 7.3L, the primary purpose of this test is to check the functionalilty of the High Pressure Oil System and the Exhaust Back Pressure Solenoid. On the 6.0L this test may return Misfire, VGT, or Glowplug codes.

7.3L Powerstroke Starting Req.:
Vehicle Power: 10.5v
RPM Signal : 100rpm
Inj. Cntrl Press. (ICP): 0.85v (about 500psi)
Fuel Pulse Width: 1 to 6 milliseconds

6.0L Powerstroke Starting Req.:
Vehicle Power : 10.5v
RPM Signal: 100rpm
Inj. Cntrl Press. (ICP): 0.85v (about 500psi)
Fuel Pulse Width : 0.5 to 2 milliseconds FICM SYNC and SYNC Achieved

*Note: the above starting requirements for both 7.3L and 6.0L Powerstroke Diesels assume the following:

- Sufficient Oil Level and Pressure
- Acceptable Quality Fuel
- Sufficient Fuel Pressure
- Sufficient Air Supply
- Proper Glow Plug Operation
- Proper Injection Timing (PCM Controlled)

P1298 - "IDM Failure" (7.3L)[indent]This code can be set by a low battery. Connect a battery charger, clear codes and re-run KOEO tests. If this code doesn't return, check charging system and batteries and repair as necessary. If the code returns, IDM is suspect.

P1316 - "IDM Codes Detected" (7.3L) IDM Codes are stored in memory in the IDM itself. The P1316 DTC is an indication that there are stored IDM Codes that need to be retrieved and/or cleared. Executing a "Clear Codes" will clear both PCM and IDM codes...DO NOT CLEAR CODES until you have retrieved and reviewed the codes stored in the IDM! If you get a P1316 DTC, the following steps will allow you to view the stored codes in the IDM using **AutoEnginuity**:

1. Execute a KOEO (Key On Engine Off) Test.
2. Execute an Injector "Buzz" Test.
3. The displayed results from these tests will include any stored IDM Codes.

Please keep in mind that IDM Codes are stored in memory. If you have a code indicating a fault, but there is no drivability problem, the fault may not currently exist. After taking note of the codes, execute a "Clear Codes". At this time you should be able to re-run the above tests with no IDM codes generated. If one or more IDM codes are still present after the "Clear Codes" command has been successfully executed and the above tests performed again, the fault still exists and further examination is necessary.

P1211 - "ICP Higher/Lower Than Desired" (7.3L) We all know that this code is commonly caused by "Hot Chips" that are demanding more Pressure (ICP) than the High Pressure Oil Pump can deliver. For what it's worth, these are the exact parameters that trigger this code:

- ICP 410psi Higher Than Desired for 7 Seconds
- ICP 280psi Lower Than Desired for 7 Seconds

This code can also be caused by legitimate High Pressure Oil System issues. Below is a list of some of the causes:

- Failed or Sticking IPR (Injection Pressure Regulator)
- Failed or Weak HPOP (High Pressure Oil Pump)
- Any Leak in High Pressure Oil System (o-ring, stuck injector, etc.)
- Low Fuel Pressure (Rare)

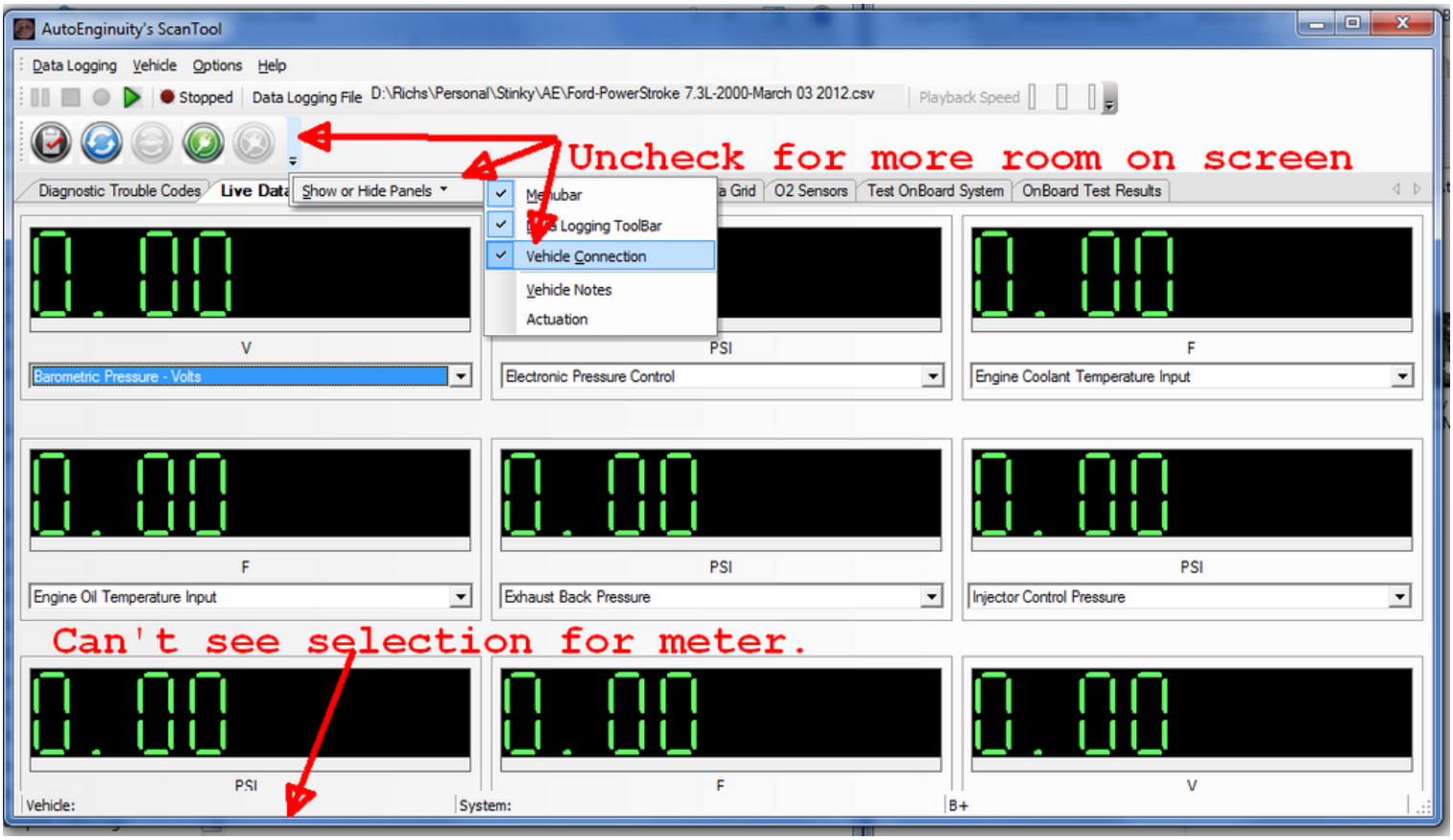
P1280 / P1281 / P1283 - (7.3L)
The above codes are related to ICP also. If the Service Engine Soon (SES) light is on and these codes are present, the ICP reading through any scantool will not be accurate as the PCM is using a "default" ICP value. These codes are all "electrical" in nature. Common causes are shorts between the Red and White IPR wires or between the Red wire and ground. These can also sometimes indicate a PCM problem.

Chapter 3

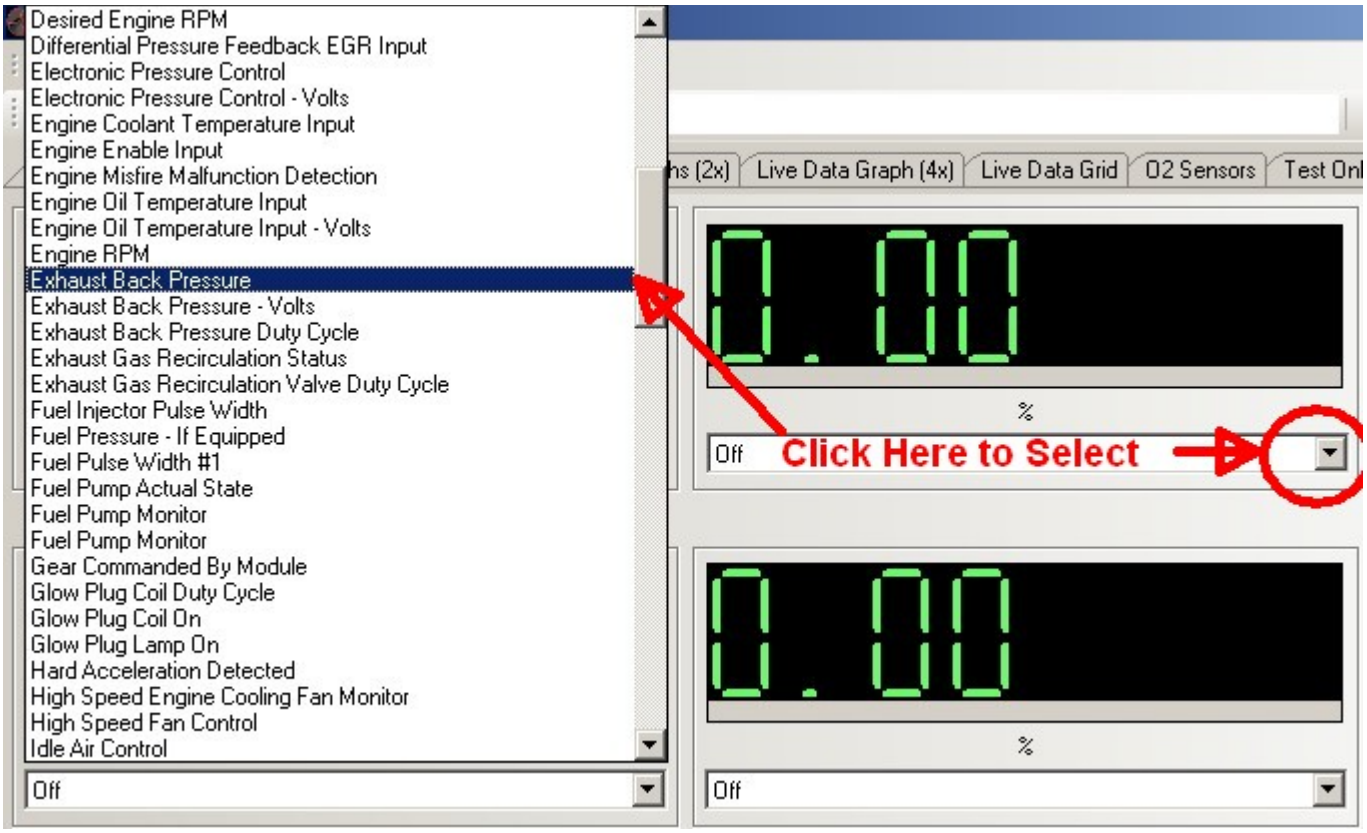
Staying with the basics:

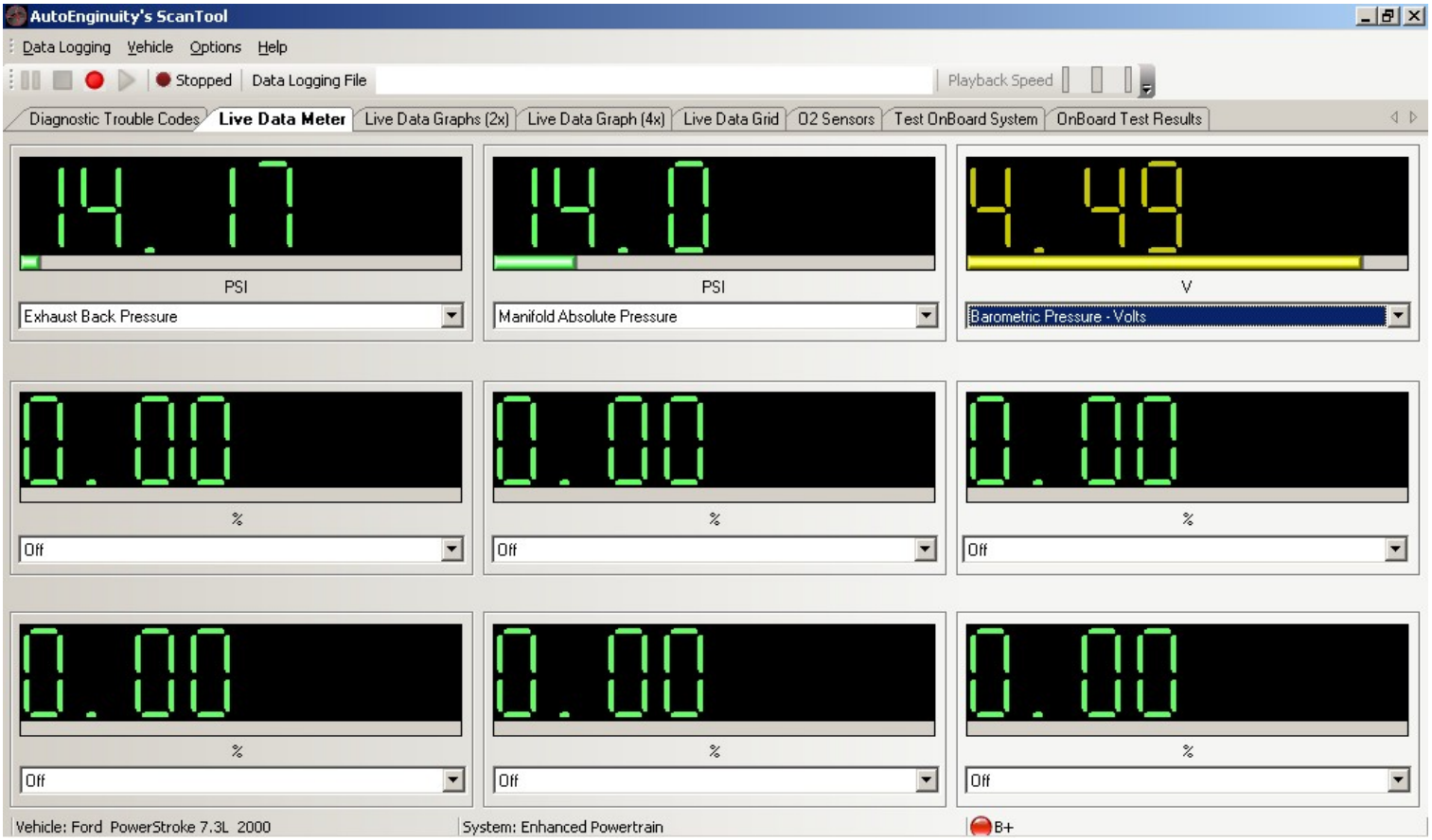
I want to start with a simple reading that is easy to overlook, but can have a profound effect on your fuel economy and performance - the Exhaust Back Pressure sensor, Manifold Air Pressure sensor, and BARO (barometer). These three are akin to a GPS indicating “you are here” for everything that follows, once the truck is started: It does no good to “Turn right here” if the GPS thinks you're someplace you're not. It also does no good if your engine tuning says “Set fuel delivery to X” if the sensors are lying to the PCM.

Before we go on a clicking rampage, you first want to see the screen. Many of you have larger screens than my netbook, but just as many are as crowded as I am. To preview if your screen can handle the whole nine bards (not a typo, just taking creative license), click on the “Live Data Meter” tab. The screen shot below contains some inspiration as to how to make more room on the screen, if needed:



Now I've done it... I gave away one of the secrets - you can monitor up to 9 sensors at a time. There will be a later discussion on the *practical* number of meters up, but I will be keeping as few meters active as possible. This test calls for just three meters... perfect. Using the screen shot below, you want to select one sensor for each meter, until the meters look like the second screen shot below that.


Desired Engine RPM
Differential Pressure Feedback EGR Input
Electronic Pressure Control
Electronic Pressure Control - Volts
Engine Coolant Temperature Input
Engine Enable Input
Engine Misfire Malfunction Detection
Engine Oil Temperature Input
Engine Oil Temperature Input - Volts
Engine RPM
Exhaust Back Pressure
Exhaust Back Pressure - Volts
Exhaust Back Pressure Duty Cycle
Exhaust Gas Recirculation Status
Exhaust Gas Recirculation Valve Duty Cycle
Fuel Injector Pulse Width
Fuel Pressure - If Equipped
Fuel Pulse Width #1
Fuel Pump Actual State
Fuel Pump Monitor
Fuel Pump Monitor
Gear Commanded By Module
Glow Plug Coil Duty Cycle
Glow Plug Coil On
Glow Plug Lamp On
Hard Acceleration Detected
High Speed Engine Cooling Fan Monitor
High Speed Fan Control
Idle Air Control
Off
Live Data Graph (4x)
Live Data Grid
O2 Sensors
0.00
%
Off
Click Here to Select
0.00
%
Off


AutoEnginuity's ScanTool
Data Logging
Vehicle
Options
Help
Stopped
Data Logging File
Playback Speed
Diagnostic Trouble Codes
Live Data Meter
Live Data Graphs (2x)
Live Data Graph (4x)
Live Data Grid
O2 Sensors
Test OnBoard System
OnBoard Test Results
14.17
PSI
Exhaust Back Pressure
14.0
PSI
Manifold Absolute Pressure
4.49
V
Barometric Pressure - Volts
0.00
%
Off
Vehicle: Ford PowerStroke 7.3L 2000
System: Enhanced Powertrain
B+

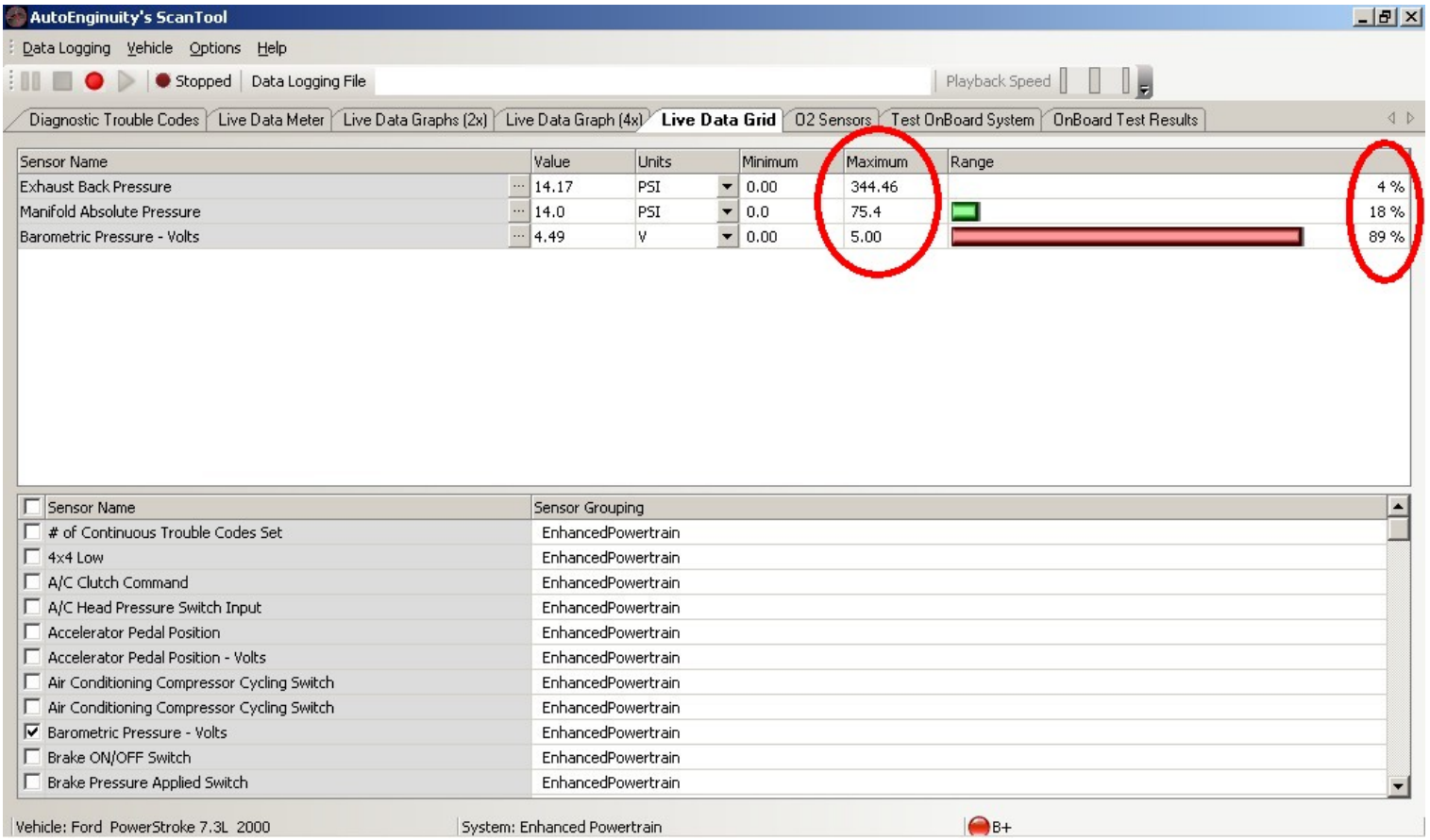
You can see the values from my truck in my driveway... I live at about 1000 feet. These values are *absolute* pressure – this means compared to a perfect vacuum, the air pressure at my home is just over 14 PSI. That's zero for a back pressure gauge and the boost gauge, so you can see how relevant this test is. Here is a [LINK] to see what pressure you should see at *your* altitude.

*****Critical edit: Powering your laptop from the cigarette lighter while using the USB-style OBDII interface has the potential to damage the interface and/or your laptop. Contact AutoEnginuity for input before powering your laptop from the vehicle.*****

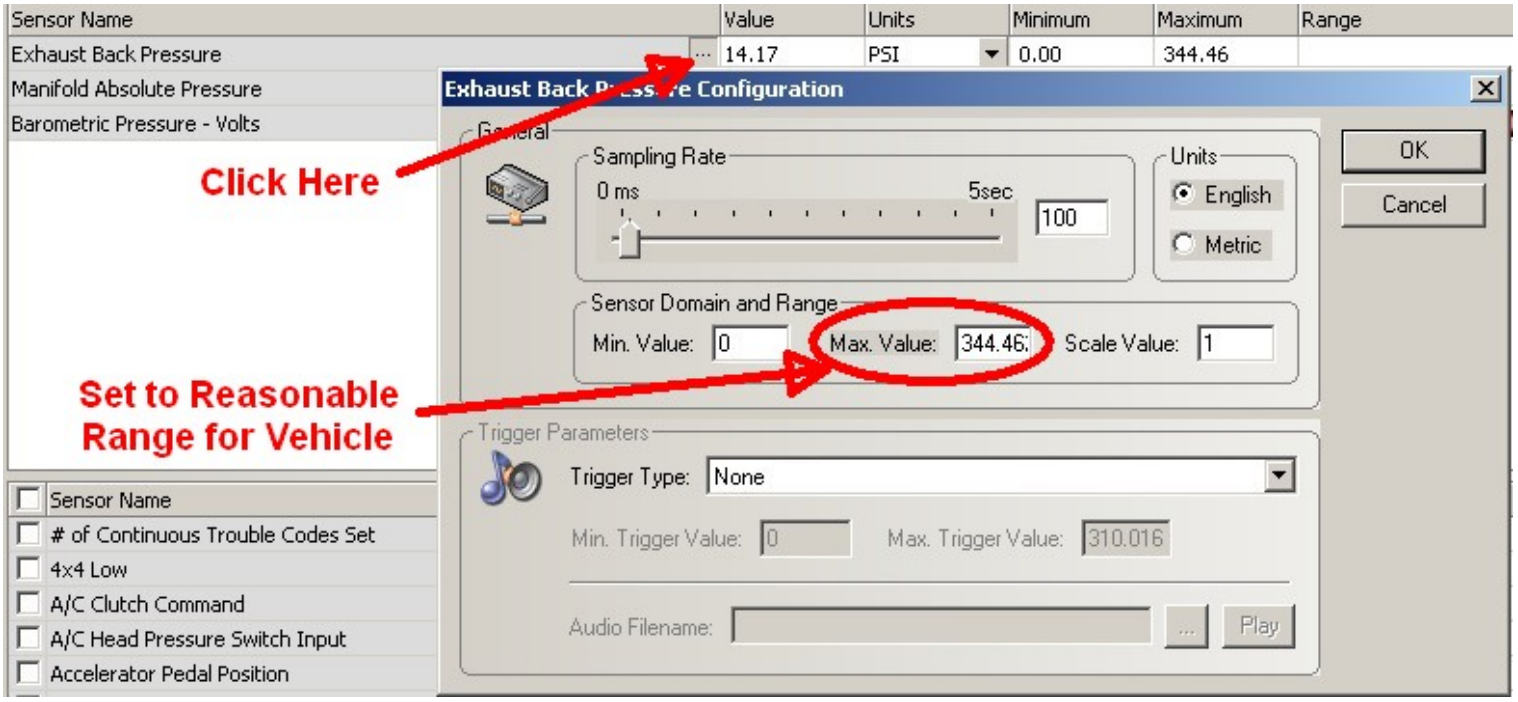
What's my next session? Setting up the system to record these three values while we go for a drive. There's more to it than just pushing the shiny red button, but I always encourage experimentation... it makes for better questions.

Chapter 4

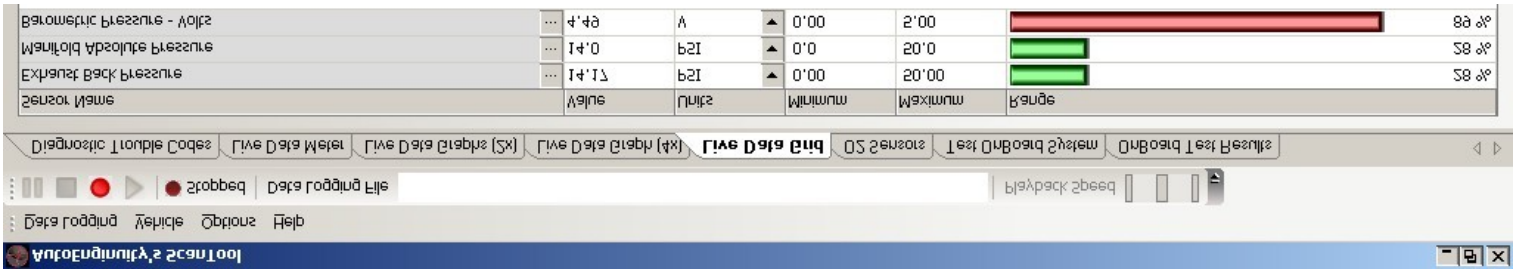
I mentioned recording data, but we're not ready for that yet: There's a little-known secret in AE that really should be less of a secret: The default maximum for each sensor sucks. Say you want to graph your backpressure after you recorded your data, the most a stock truck will see is maybe 65 PSI absolute – and that's being pushed downhill in second gear by a heavy load. Click on the "Live Data Grid" tab and look at the default maximum for backpressure in the screen shot of below:


AutoEnginuity's ScanTool
Data Logging Vehicle Options Help
Stopped Data Logging File
Playback Speed
Diagnostic Trouble Codes Live Data Meter Live Data Graphs (2x) Live Data Graph (4x) Live Data Grid O2 Sensors Test OnBoard System OnBoard Test Results
Sensor Name Value Units Minimum Maximum Range
Exhaust Back Pressure 14.17 PSI 0.00 344.46 4 %
Manifold Absolute Pressure 14.0 PSI 0.0 75.4 18 %
Barometric Pressure - Volts 4.49 V 0.00 5.00 89 %
Sensor Name Sensor Grouping
# of Continuous Trouble Codes Set EnhancedPowertrain
4x4 Low EnhancedPowertrain
A/C Clutch Command EnhancedPowertrain
A/C Head Pressure Switch Input EnhancedPowertrain
Accelerator Pedal Position EnhancedPowertrain
Accelerator Pedal Position - Volts EnhancedPowertrain
Air Conditioning Compressor Cycling Switch EnhancedPowertrain
Air Conditioning Compressor Cycling Switch EnhancedPowertrain
Barometric Pressure - Volts EnhancedPowertrain
Brake ON/OFF Switch EnhancedPowertrain
Brake Pressure Applied Switch EnhancedPowertrain
Vehicle: Ford PowerStroke 7.3L 2000
System: Enhanced Powertrain
B+

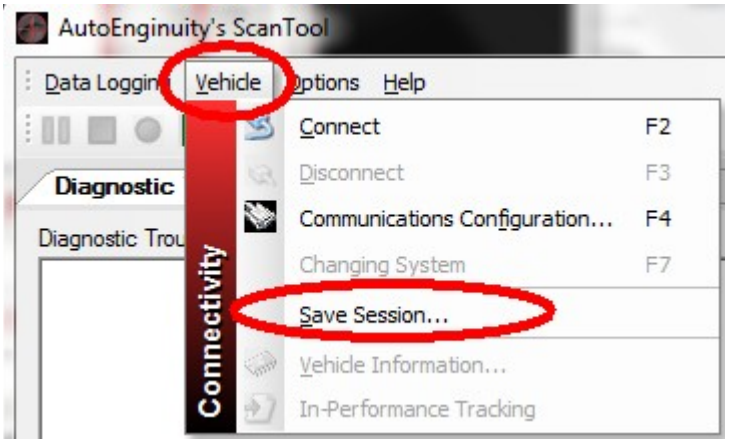
40 PSI (heavy load) on a graph from zero to 344.46 (where do they get these numbers?) is going to look like a speed bump, and you want a freeway overpass. Graphing aside, if we saw 300 PSI backpressure, we wouldn't be looking at AE data... we'd be looking at the engine parts on the road that we coasted over. AE is set up with default maximums to fit the most wild factory vehicle. Another example is the engine speed (RPM): The default maximum in AE is 8000. That's just silly for a diesel, so every meter we want needs a visit to the "Live Data Configure" screen.



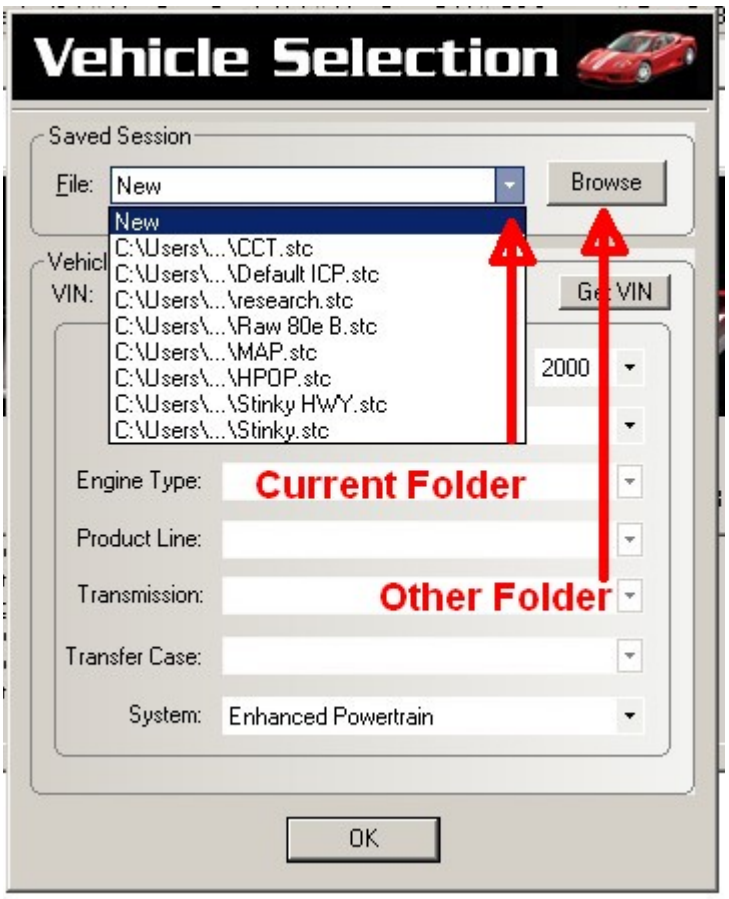
I set my absolute pressure maximums to 50 for this exercise, but a realistic maximum for my modified truck would be 65 on the backpressure and 55 on the MAP. The question about alarms was asked – that's the trigger in the screen. I'm not covering it yet, but that's another toy for you to experiment with before I get there. If you get playful, you can set a MAP limit on a stock truck to 30 PSI absolute... then it will play an audio file that cries out “Cap'n! I don'-a think she'll take much more!” (which you have to acquire on your own). I digress... here is the screen shot with the maximums set to be reasonable.



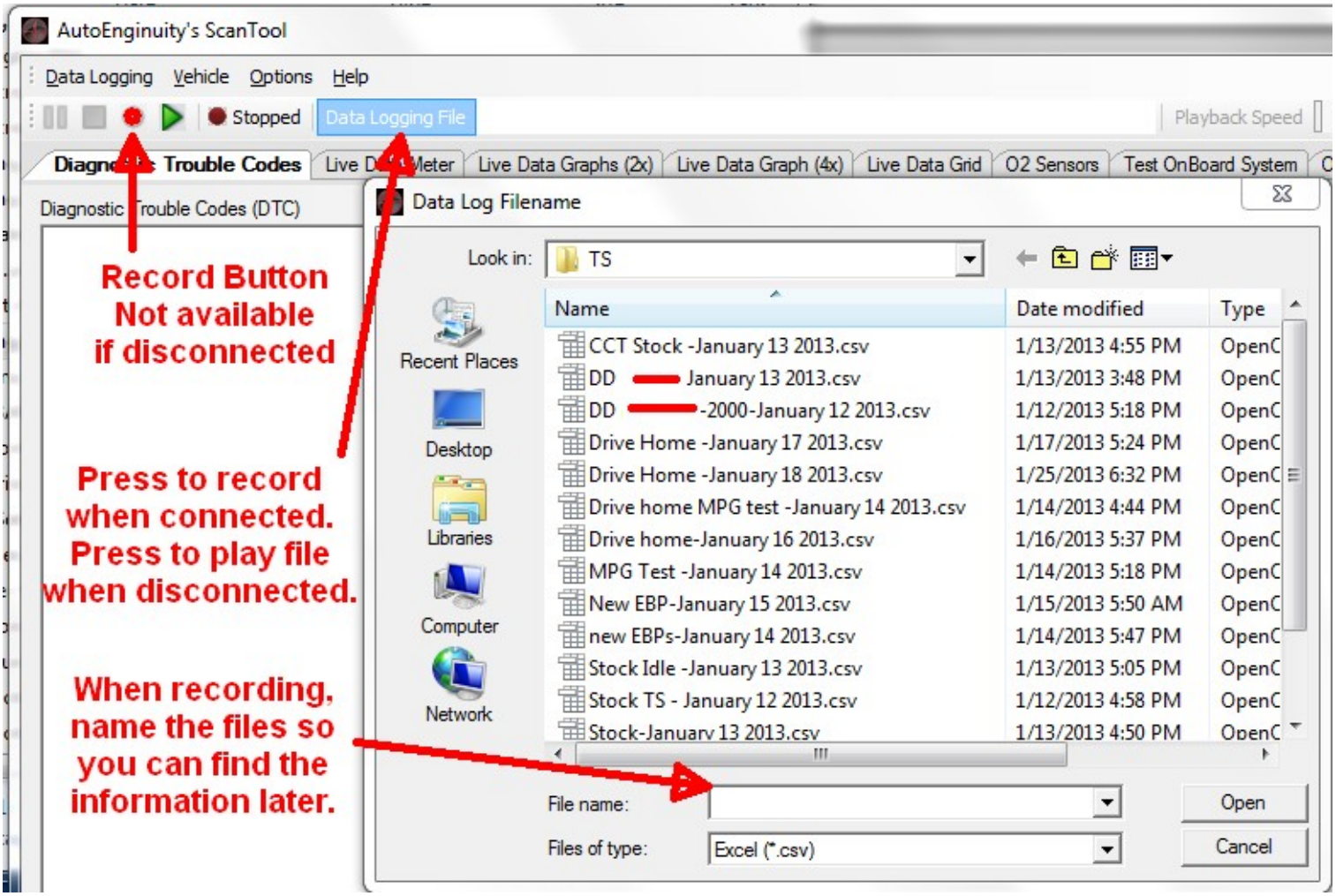
We went through all this trouble to select the sensor and set the maximums for good graphing, now we don't want the software to set everything back to default when we disconnect – so we save the session. Click "Vehicle” on the menu, then “Save Session”. Give it a name you can remember – like “Tugly's class” (I have a chance here to be immortalized and I don't want to pass it up). The file name Exh-Boost would probably work better.



The next time you connect to to the vehicle, you can start a new session, or you can load a prepared one like the Exh-Boost you just made. Here are some saved sessions I have on file:



Well... that's it, now we need to start recording and start an engine. Record first, get 10 seconds of data, then start up and go for a drive. If you get a chance to get a WOT session, all the better.



Word of warning: I learned the hard way that if you change a parameter while in record, the recording will stop instantly. Once you are set up and recording, you are committed to that meter set until the next recording session. While recording, you can hit pause at any time and start back up by hitting the pause button. There is a stop button as well, which will complete that recording file. If you hit stop and want to record more, you need to start a new file. If you allow the software to auto-name the recording files, it will just name it for the vehicle, model year, and today's date. If you record twice in one day, it will delete your first recording... unless you give the second recording a different name than the first one.

Obviously, working with filenames and meter parameters is not to be done while driving... though some have tried. I strongly urge you to leave the computing time to the side of the road, or have an assistant tend to it.

What's next, you say? We're going to look at your data... might I suggest you record some? "Oh my gawd! This has homework!?!"

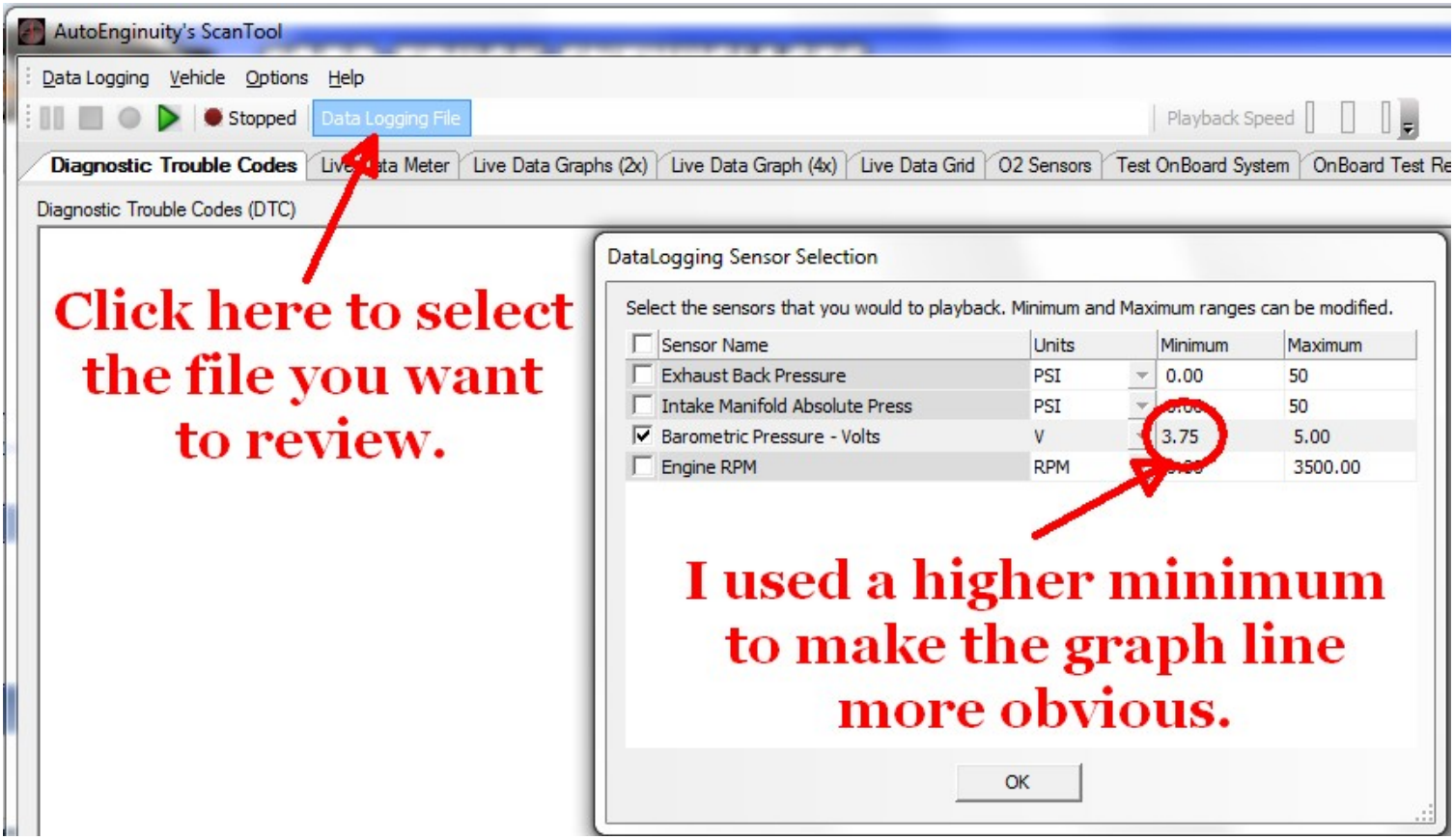
Chapter 5

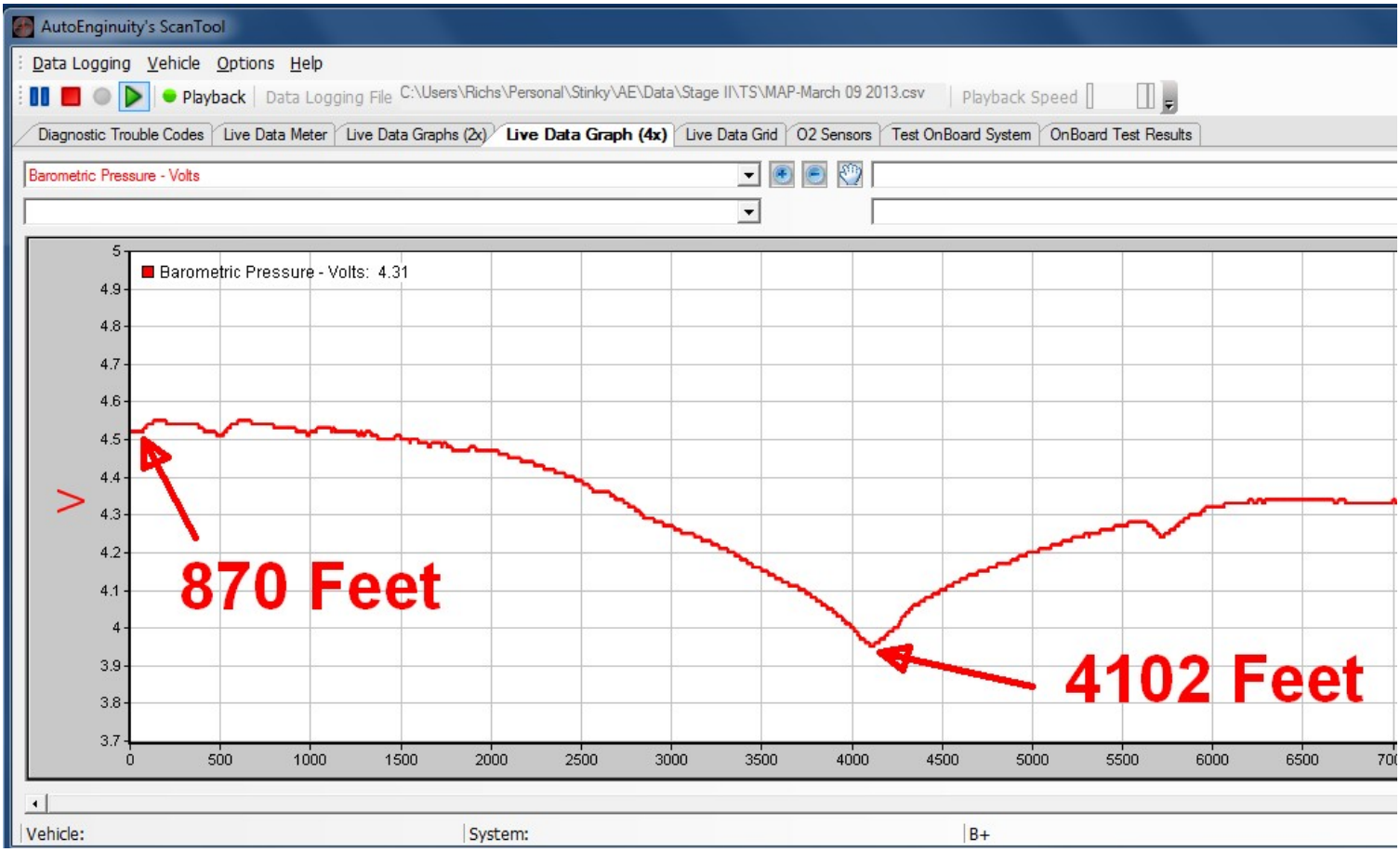
More AE basics: Playing back a file you recorded.

I'll do just one sensor, so you get the idea... then you can practice with one or more sensors that you have recorded while tinkering with AE. I used BARO because it points out a few important things:

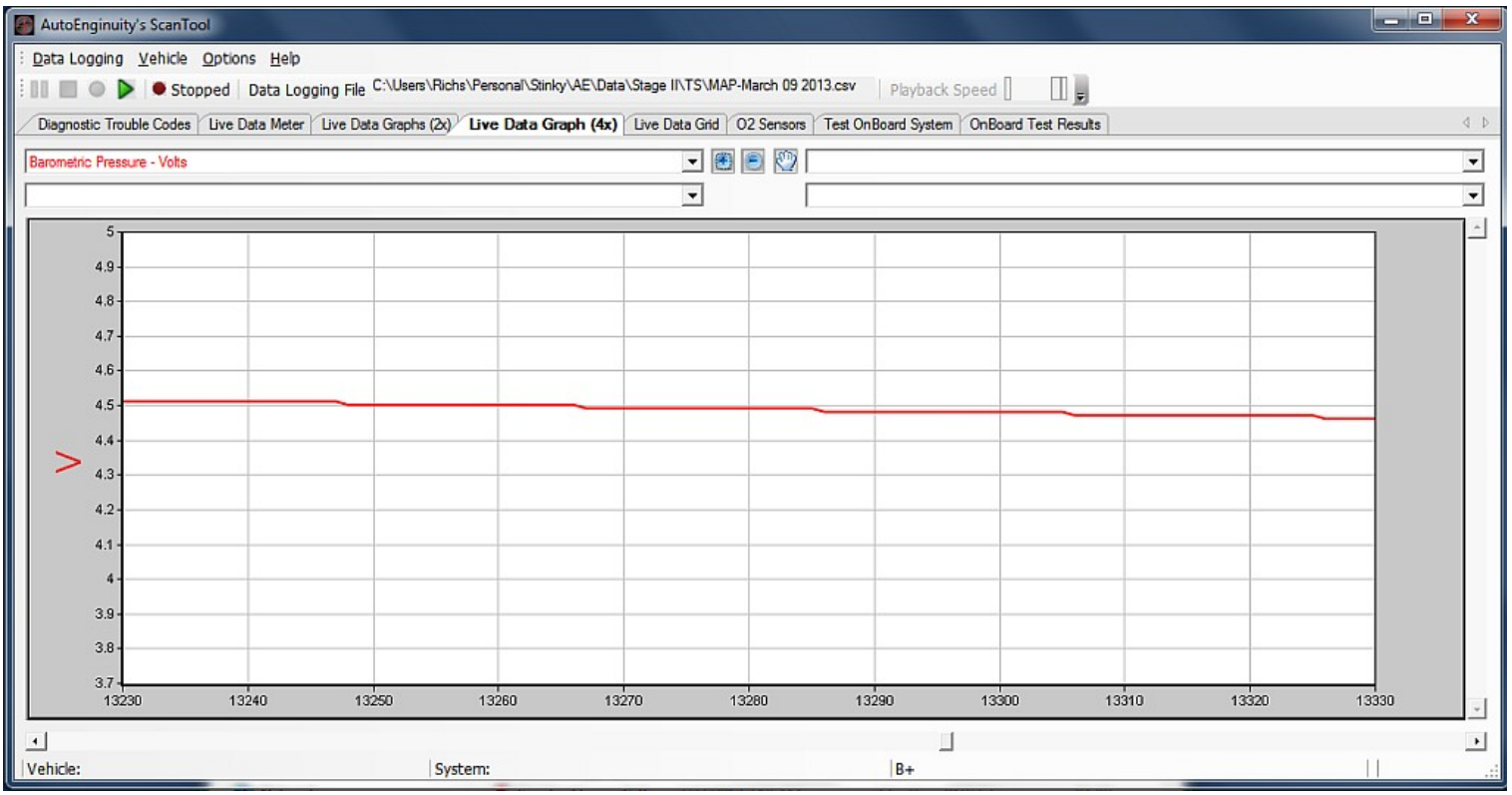
- Not all sensors need the same attention, BARO probably needs the least. Engine Oil Temperature is important, but it's a slow mover... unlike Injector Control Pressure. I set my BARO to be looked at once every 5 seconds... I'll show you how to do that later.
- With these slow changes, looking at the sensor over the time of say... a minute... you'll see a very boring flat line. I recorded BARO over a very long time while changing altitude and I got a useable graph where I can see what my elevation was as I was driving. The importance of this is again for a later lesson.
- Some sensors have huge ranges during operation, like RPMs... they go from 600 at idle, to 3200 or so on a stock truck. The default setting for RPM in AE is 8000... silly for a diesel and the graphing will look a little flat. I set my RPM maximum at 3500. The BARO is a sensor that has tiny changes, so the "scaling" has to be tiny, if you are going to see these changes on a graph. Default max for BARO is 5 volts - perfect, because sea level is about 4.7 volts.
- When playing back my BARO on a graph, I want the biggest rise and fall I can get to make the altitude change obvious (without going off the graph), so I changed the minimum. Why change the minimum? Zero volts is a perfect vacuum and I didn't dock withe the International Space Station on this particular drive, so I set a realistic minimum for the altitudes I experienced.

Here are a few thousand words on the procedure.





This is what happens when you look too closely at a slow-moving sensor. Very boring:

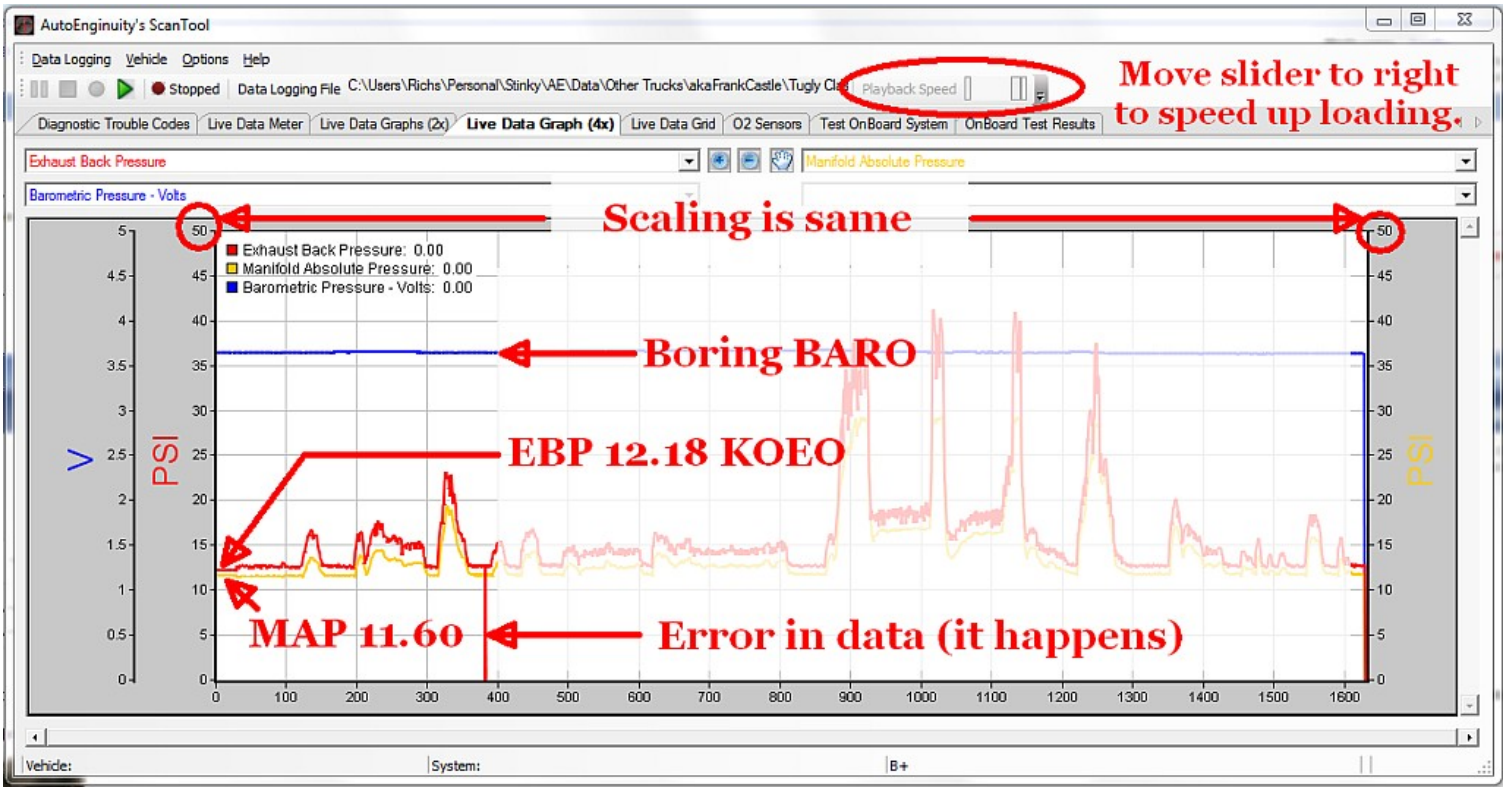


I skipped over a few things that may or may not be obvious to Scan Tool users. In the event the above is a bit confusing, I'm pausing for questions.

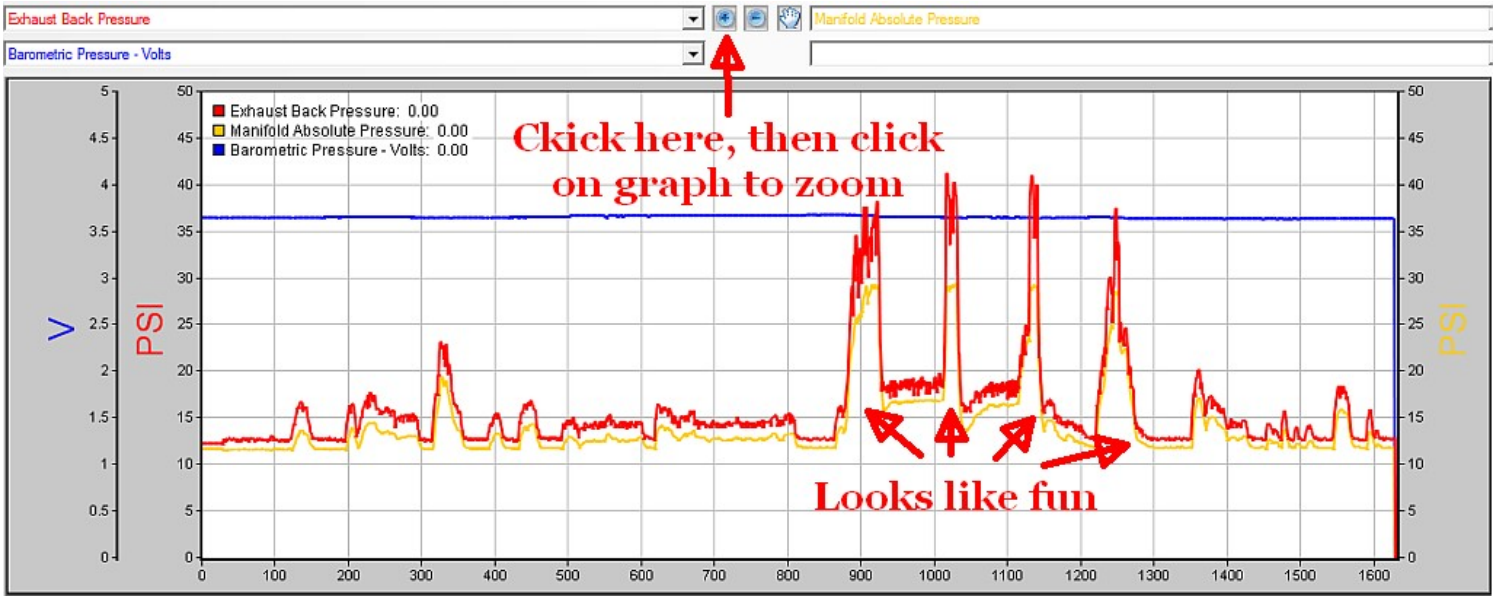
Chapter 6

I will be using **akaFrankCastle**'s data to point a few things out. I have attached the "modified" data that anybody with AE can open up and follow along. Download the file and right-click on it, then select "Rename". Where the file name says DOC, change that part to CSV.

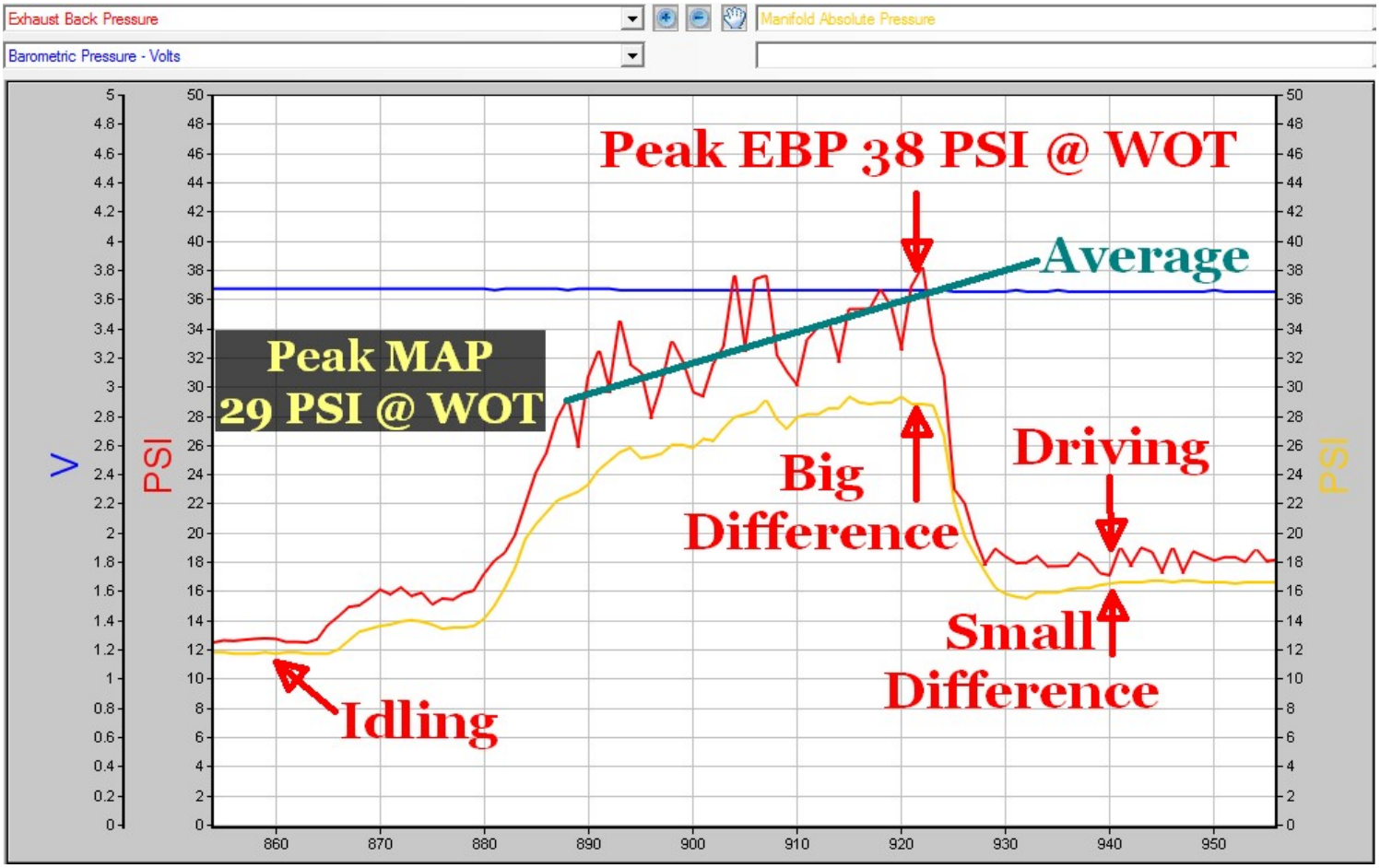
Since this has so much data, it will try to "play" the data out in real time upon loading. It will take a long time to load, so you want to move the "Playback Speed" slider all the way to the right in order to fast-forward. After the whole file has loaded, the graph will display everything that will fit in the time limit of the AE software. This data recording is just short enough to fit this file on one screen. Remember, these pressures are "absolute", so that means they are the atmospheric pressure at your altitude *PLUS* the pressures built up in the engine at that moment. Here are some notes on the raw data I received:



I cleaned up the error and we have this:



I then made my AE screen bigger to see more detail and zoomed in on the first spike on the graph:



You can see how the backpressure (EPB plus EBP KOEO reading) stretches above the MAP (boost plus the MAP KOEO reading) when we get on our trucks. We lose efficiency in the stock turbo at higher pressures and this is a normal result. Doing the math:

- EBP (absolute) peak is 38, but we subtract the EBP KOEO of 12 to get the *real* ehaust backpressure of 26 PSI.

- MAP (absolute) peak is 29, but we subtract the MAP KOEO of (roughly) 12 to get the *real* MAP (boost) of 17 PSI.

This looks to be *textbook* for a healthy stock truck (Wicked Wheel notwithstanding), until I find data that says otherwise. Of course, we have no other data like speed or RPM to see how the truck is reacting to this powah... but I wanted to keep this very basic to give everybody a chance to absorb the information.

Now I'm watching for somebody to raise their hand for a question.

Chapter 7

Why during the closeup of the wot run...are there more spikes than gears?

The RPM data wasn't in the file, but I can estimate.

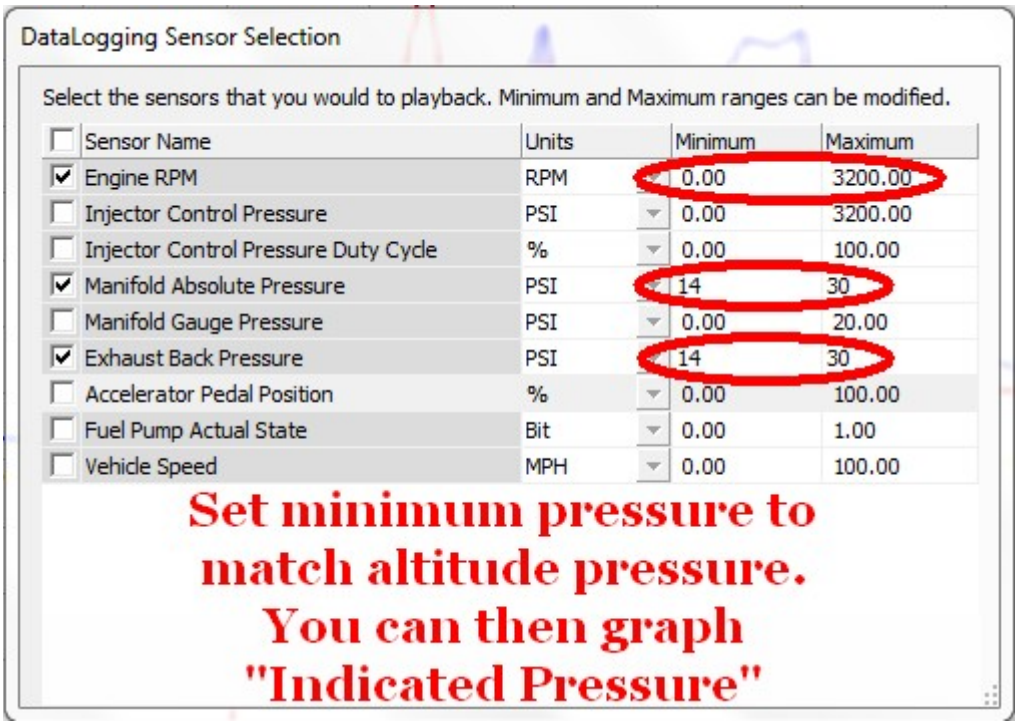
The thing to note is how the backpressure builds higher as the load increases (wind load, higher gearing, and speed)... this is the breeding ground of high EGTs.

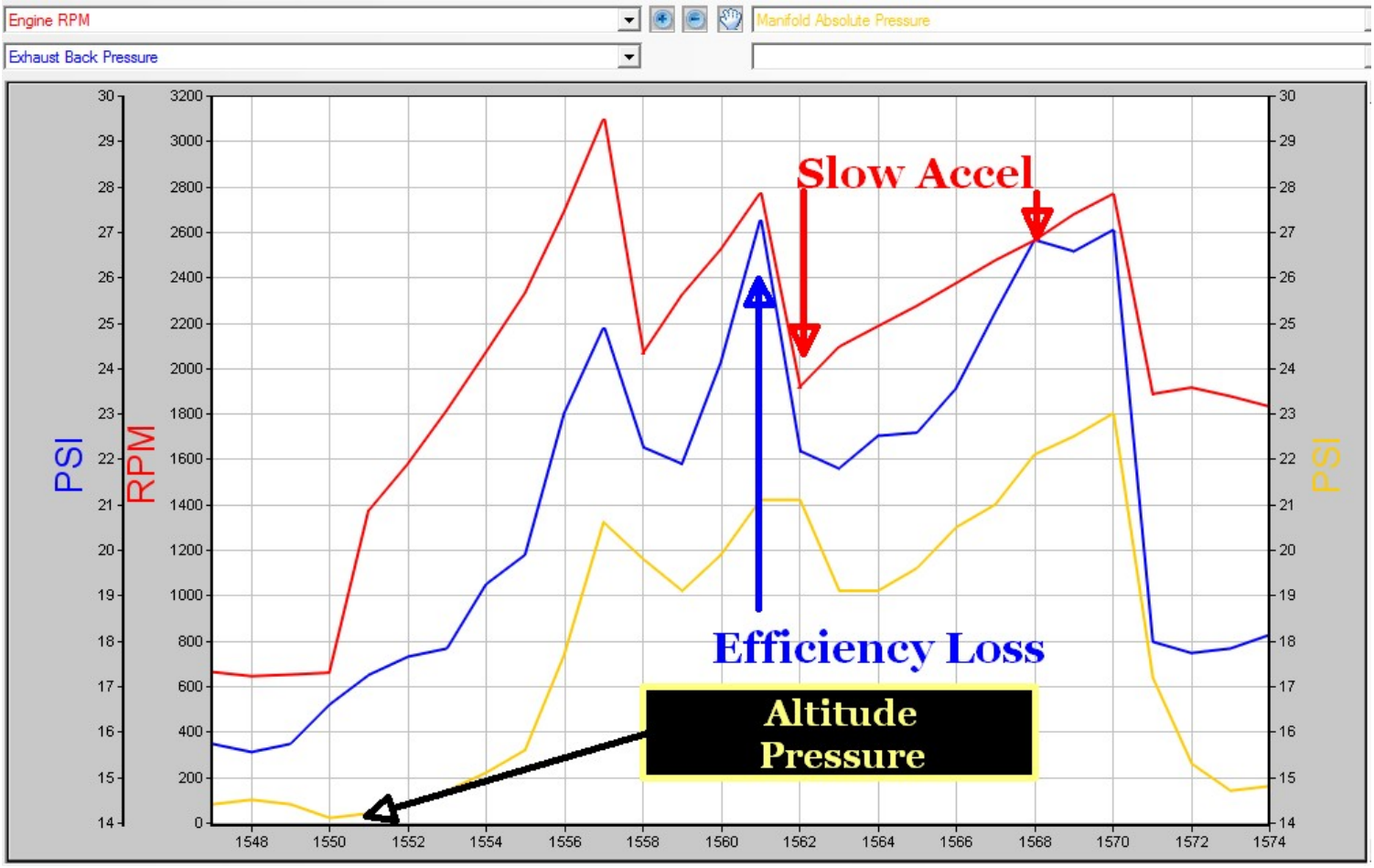
EBPV sticking? I'll look for another example of EBP/MAP data from a stock truck at WOT. I should have some here.

Chapter 8

Here's an experiment: I have some other data from a truck that isn't faring so well (assuming the data is from a WOT run). I set the MAP and EBP minimum pressure readings to match the pressure for the altitude. This gives me a graph that only shows boosted

exhaust and intake pressures. This data has RPM so you can see what your engines do:


DataLogging Sensor Selection
Select the sensors that you would to playback. Minimum and Maximum ranges can be modified.
Sensor Name | Units | Minimum | Maximum
Engine RPM | RPM | 0.00 | 3200.00
Injector Control Pressure | PSI | 0.00 | 3200.00
Injector Control Pressure Duty Cycle | % | 0.00 | 100.00
Manifold Absolute Pressure | PSI | 14 | 30
Manifold Gauge Pressure | PSI | 0.00 | 20.00
Exhaust Back Pressure | PSI | 14 | 30
Accelerator Pedal Position | % | 0.00 | 100.00
Fuel Pump Actual State | Bit | 0.00 | 1.00
Vehicle Speed | MPH | 0.00 | 100.00
Set minimum pressure to match altitude pressure. You can then graph "Indicated Pressure"



When I compare this with the data from before, it's easy to spot the "Ham Sammitch" factor and the "Where's the Beef?" syndrome.

Neither set has Bacon/Permagrin, because we're dealing with stock. Note how higher EPB doesn't translate to exactly the same boost rise on the MAP side... that's stock turbo efficiency.

So... with a stock truck, it's not unusual to see about 1 PSI difference between exhaust and intake at cruise speed, and about 6-9 PSI difference at WOT. That's about what I saw on Stinky when he had stock hardware with a tuner... but the numbers were taller. I would get about 36 PSI indicated backpressure and... oh... 28 PSI indicated boost at the MAP (30 on the hot side of the intercooler). There are a lot of variables, like altitude, temperature (combined makes air density), condition of the truck, air filter, exhaust configuration, blah-dee-blah-blah....

If you are looking at your truck with a scan tool, expect 1-3 PSI differential between EPB and MAP while driving "sanely". You'll see between 6 - 9 or even 10 PSI differential at high load... like WOT at high speed, pulling a grade, a headwind, or trying to break something at a tractor pull. If your EBPV is on because of a decel tune, expect really big pounds for backpressure readings (upwards of 40 PSI indicated) and bupkis for boost (like 1 or 2 PSI indicated).

If everybody's had enough of the EPB/MAP/BARO already, I'd like to know what you'd like to learn next. No-starts? Anemic performance? How to gauge MPG improvements with AE... instead of waiting for an empty tank? Tire size (ties in with MPG)?

Chapter 9

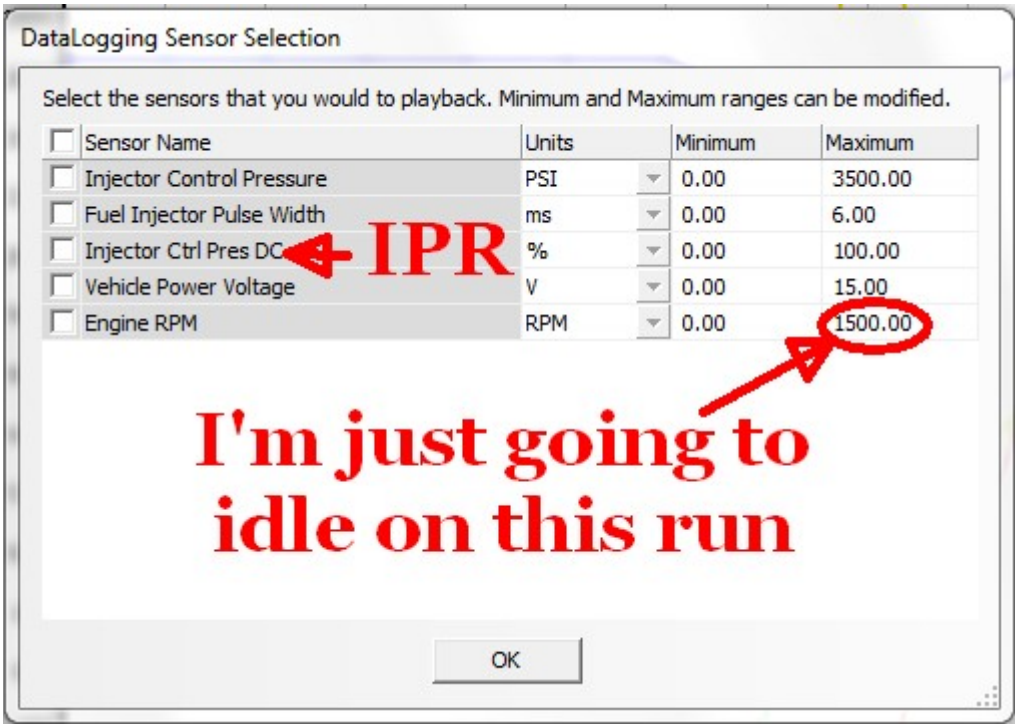
Starting

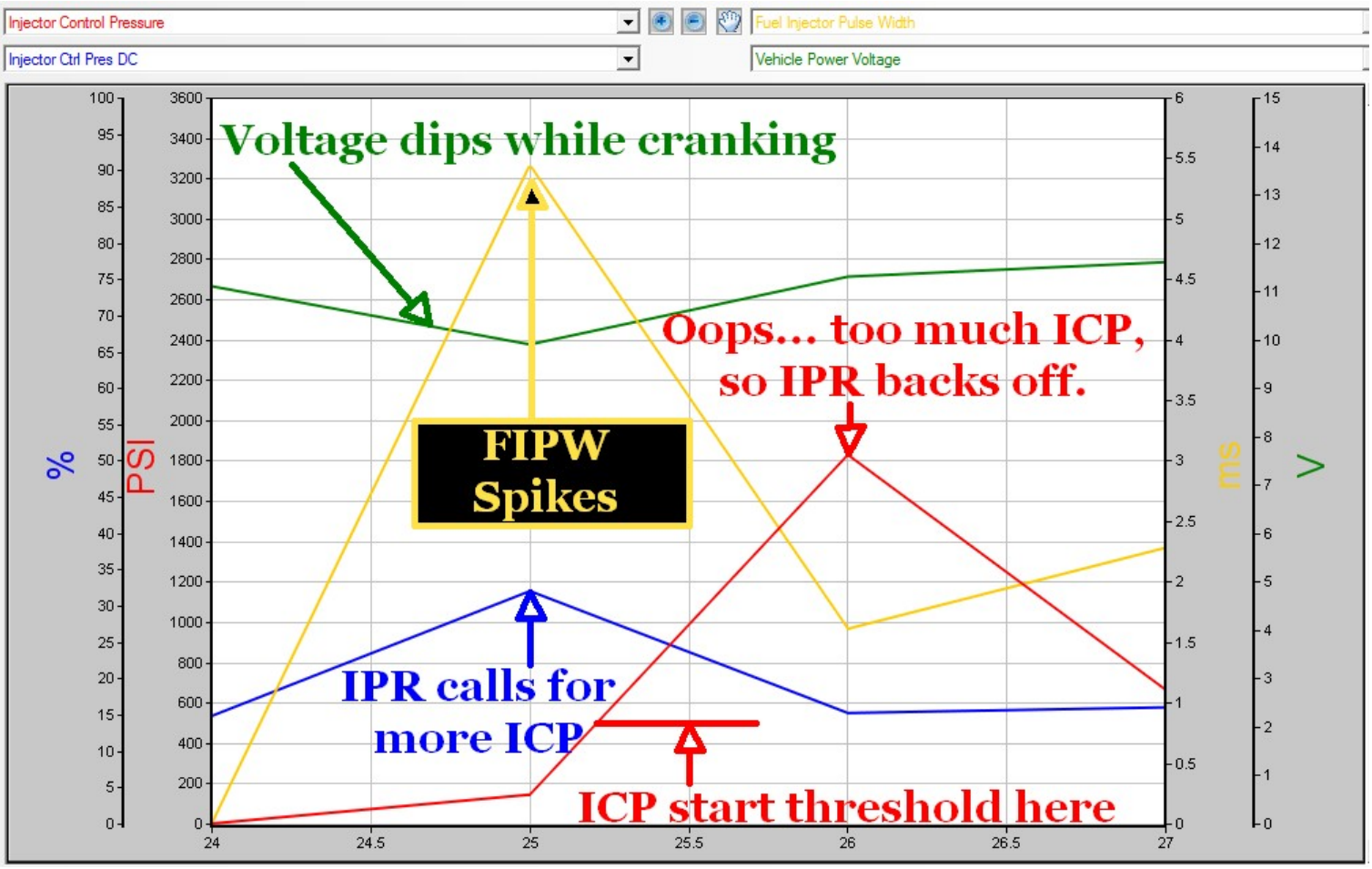
You are now about to learn what I was referring to when I mentioned "data sampling rate" when comparing AE to Infinity. With just the 5 PIDs I set up, AE recorded each one once per second. That's 200 milliseconds for each PID, for a total of 1000 milliseconds (1 second) to read them all before it came back to the first PID. It took me 1.5 seconds to start the truck (about 40 degrees, not plugged

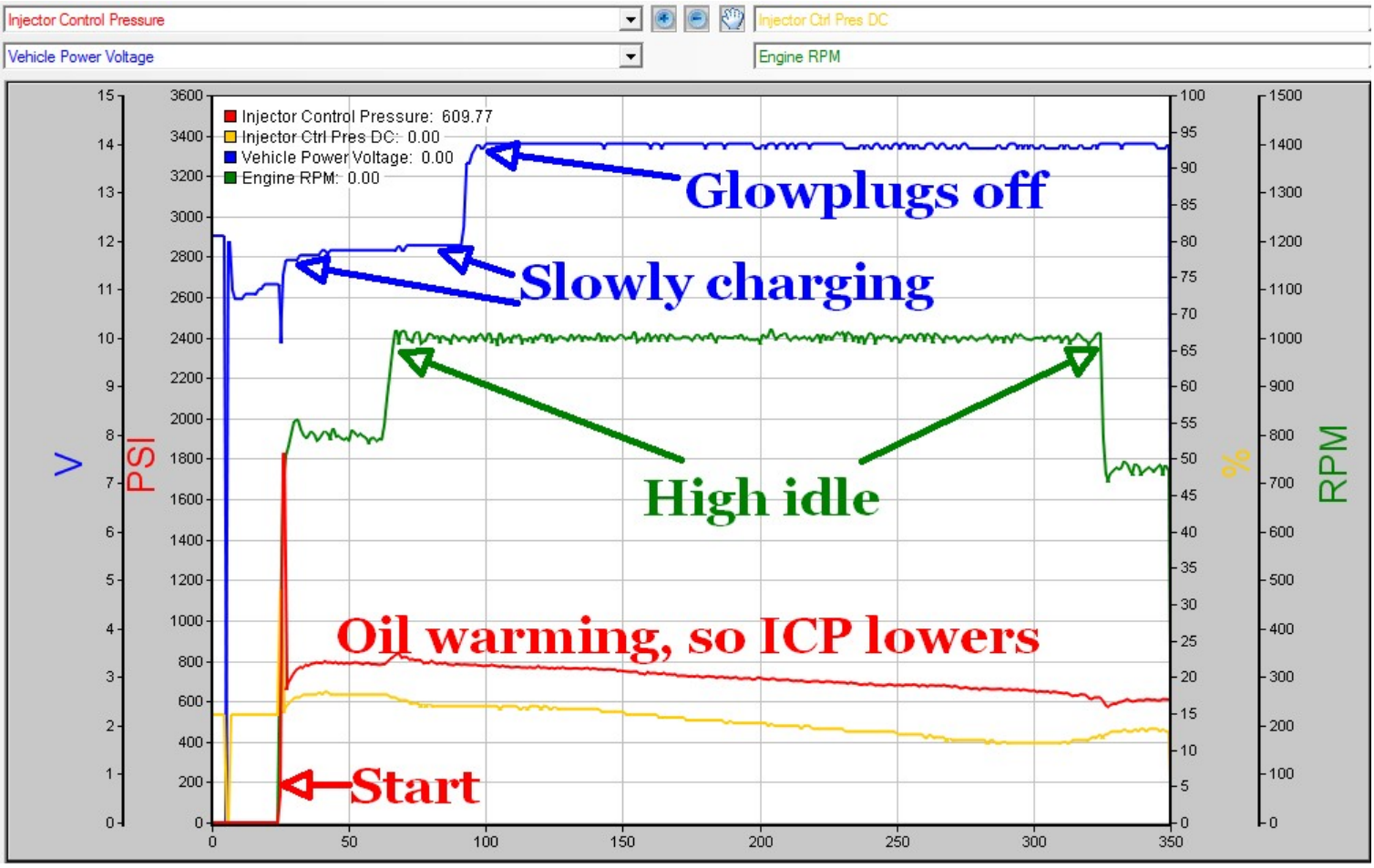
in). Any guesses how much data I got *while* it was cranking?

Anyway... I won't repeat all the steps to set up a recording session, but I will show you my playback options... which specifies exactly what I recorded to monitor the starting condition of the truck. I threw IPR in the list, so you can see the lag between what the PCM wants and when it gets it... like nooky. One piece not in there directly (like voltage) or indirectly (like glowplugs revealing themselves with a voltage drop): Fuel Pressure. I have a gauge, so fuel pressure is 62 PSI. I did not play out my pulsewidth over time because I won't show combined ICP and FIPW trends on the forum from this tuner.

I'm just posting screenshots and my notes with no other explanation. If I missed some detail or you want to know more in depth, please say/ask something.



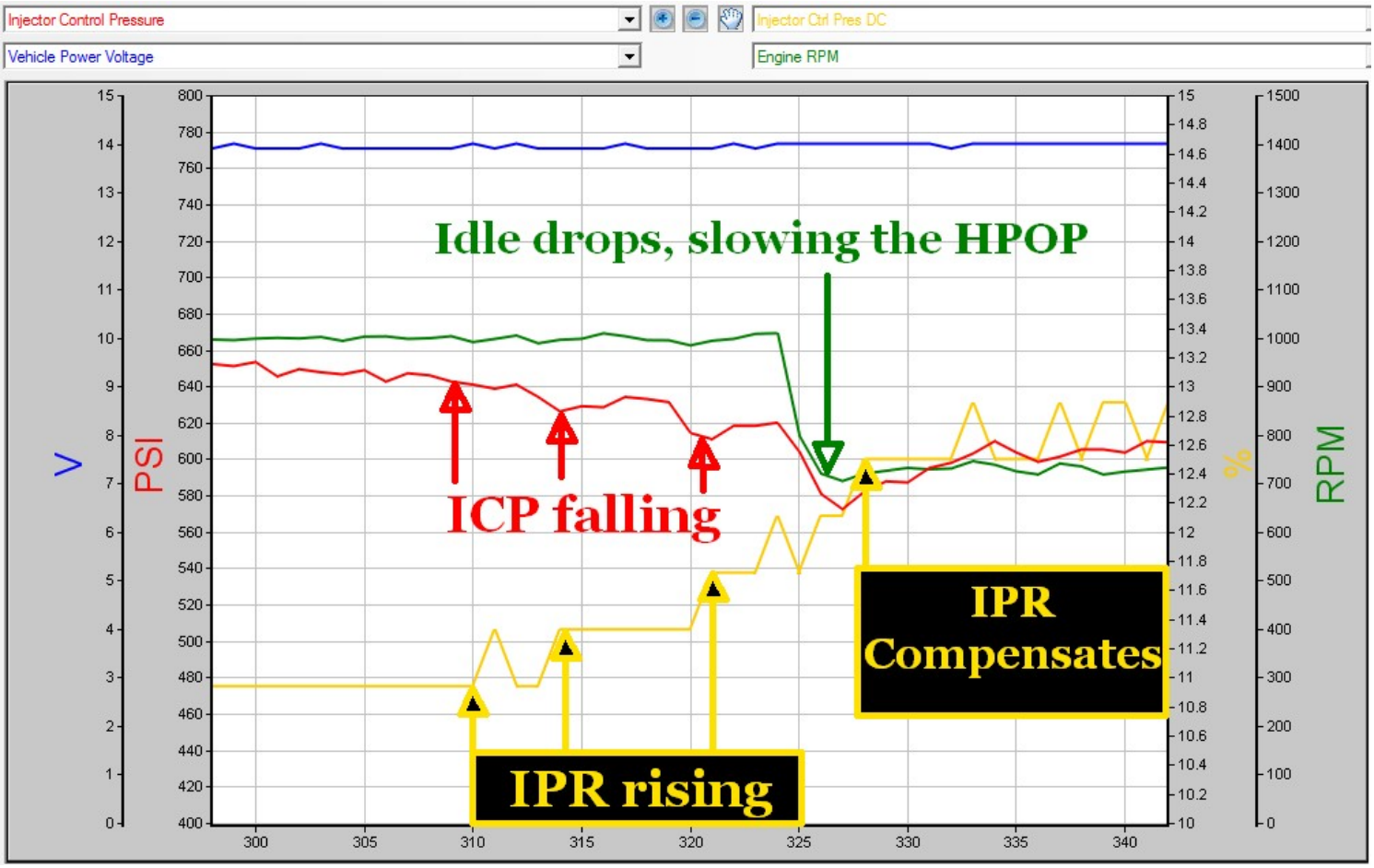

Injector Control Pressure
Injector Ctrl Pres DC
Fuel Injector Pulse Width
Vehicle Power Voltage
Voltage dips while cranking
Oops… too much ICP, so IPR backs off.
FIPW Spikes
IPR calls for more ICP
ICP start threshold here
%
PSI
ms
V



Chapter 10

So I was getting ready to show how the Injector Pressure Regulator compensates for the drop in RPMs, in order to keep the Injector Control Pressure up with a slower-moving High Pressure Oil Pump. Simply put, the pump slows down and and the valve has to be opened more to keep the oil delivery going at the same flow.

When I zoomed in on the graph, I spotted something I would not otherwise have noticed: I can see the effects of the multiweight oil warming up. The RPMs are constant and the oil pressure is dropping, which I expect because warm engines have a lower Injector Control Pressure. What I didn't expect is the regulator (oil pressure valve) is *opening* more instead of closing more, to keep the oil pressure (ICP) from falling even faster. The effects of a heavier oil weight is the only changing factor I can think of that would cause this.



So... show of dazed eyes: How many did I lose on *that* one?

Anyway, here's the significance of all of this: The Low Pressure Oil Pump (LPOP) sends oil up to the High Pressure Oil Pump (HPOP). The HPOP is always the main focus because this powers the injector. The injector gets an electrical signal to be sure (Fuel Injector Pulse Width or FIPW), but that just lets the oil in to squeeze the fuel out of the injector with great force. The higher the ICP, the better the atomization (finer fuel mist) and the faster the fuel squeezes out of the injector (quicker injection means more power and lower EGTs).

We don't need a lot of ICP at idle and cruise, that would make the fuel hard to control at such low power demand... and more ICP is just plain loud. When we first start, the engine is cold, the fuel is cold, the oil is cold... so we need a bump in ICP to get better atomization when cold. As the engine warms and the fuel burns easier, we back off the ICP by about 200-300 PSI.

Now... 15-40 vs. 5-40. My little discovery demonstrates exactly *why* lower-weight oil works better when cold: Everything moves easier with less effort. Most of you already know this, but now we can actually *see* it in the performance of the engine.

Chapter 11

I slept on it and I now have a better grasp of what needs to be done.... the basics. I got ahead of myself, sorry.

Let's start with the injector, because *everything* in starting is all about getting fuel into the cylinders. Once we have rotation (the starter doing its part) and compression (the engine doing its part), we just need some fuel please, thankyouverymuch (at the right timing). Think of it as a frat party... waiting for beer. As soon as the beer shows up, 8 lunkheads make a racket. If nobody gets beer, no party. If only some of them get beer, there's a fight, which involves a lot of bucking and kicking. If the tap on the keg just dribbles, the party stalls.

In order to get those pesky HEUI injectors to cough up some “beer”, we need:

- High oil pressure in the top half of the injector (pump up the tap)
- Fuel in the bottom half of the injector (beer in tap)
- An electrical signal to the solenoid on the very top of the injector. (thumb on the tap lever)

HPOP, ICP, IPR, LPOP, EOT, EOP.... You'd swear this is where Campbell's got the idea for Alphabet Soup... or so it would seem. What's up with all the acronyms and sensors with the letter O in it? Oil that is. Black gold. Texas tea. My plagiarism of a 60's sitcom notwithstanding, this is the big time folks. All this focus on oil is *not* overkill. We need to pare all of this down so we have a manageable dialog, not a lengthy class on technobabble. Focus on one thing – ICP (Injector Control Pressure). All that other crap... those are just parts of the puzzle to ***get*** ICP. Injector Control Pressure (ICP) – drum that in. That *is* the high oil pressure we need in the top half of the injector to make it say “Pssst.”

Believe it or not, fuel *pressure* is not so critical for firing... but enough fuel *flow* to refill each injector before it gets fired again is paramount. The closest we can get to seeing if there's enough flow is to look at the pressure, so the pressure gauge is a proxy for a flow gauge. Think about it, if a specific *pressure* value was so critical (on this truck), where's the fuel pressure sensor? Do you think they just overlooked it... after they went into convulsions on sensors for the oil? You're probably thinking “The fuel part of the truck must have been engineered in a different department and *those* guys are idiots.” Well... while this has some merit, the fuel system is pretty basic: If you hear the pump and you know there's fuel in the tank, there is a *good* chance fuel is OK... but there are plenty of banana peels under our feet on this one. Problems that arise here are likelier due to the age of the truck more than anything else. Hence... the add-on fuel pressure gauge.

The electrical signal to the injector is a two-stage process. The Powertrain Control Module (PCM) is the brains of the operation, but the Injector Driver Module (IDM) is the a55 (you know... the donkey-looking horse). Ta-daaah. What goes on inside the PCM is uber-complex, but we have zero need to understand it for the purpose of starting the truck. We just need the appropriate sensors to tell the PCM it's party time, the PCM then needs to grab the ol' whip and crack the a55, the a55 then needs to get off same... and start haulin' same.

I mentioned sensors need to tell the PCM that the keg and the lunkheads are are ready before it's party time. What sensors? What are they supposed to say to the PCM? Before we get into that, we need:

- Sufficient oil level and pressure (the low oil pressure on the dash gauge)
- Acceptable quality fuel
- Sufficient fuel pressure
- Sufficient air supply
- Proper glow plug operation (on a cold truck)
- Proper injector timing (PCM controlled with input from Cam Position Sensor – CPS)

Now... for the AE data that will tell us the 7.3L should start:

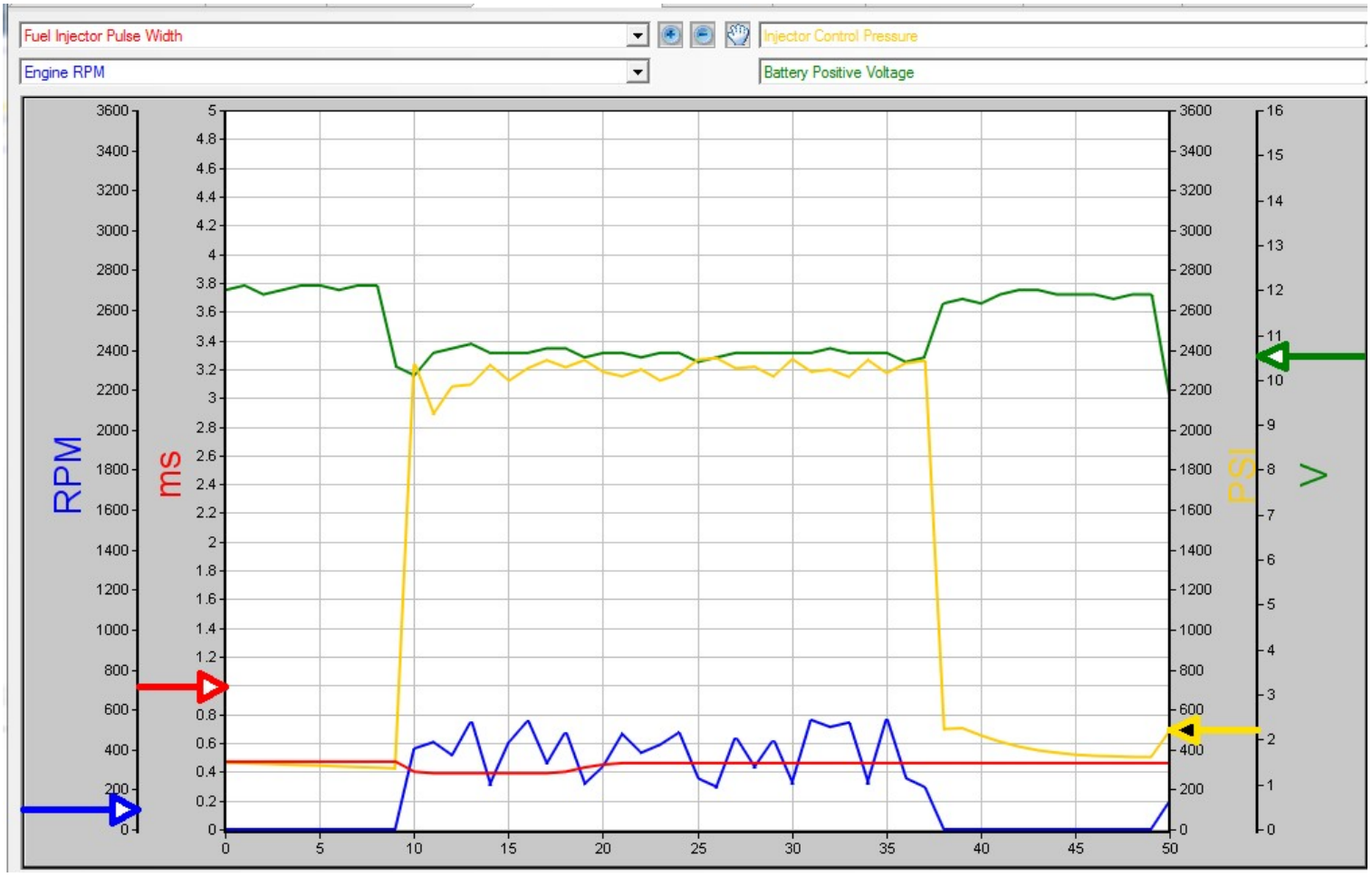
1. Vehicle Power: At least 10.5 volts with glow plugs on (but that low number is marginal... I have at least 11.5 on *my* truck)
2. RPM Signal: 100 RPM minimum (from the CPS)
3. Injector Control Pressure (that ICP you burned into your thinking... like pumping up the keg tap): 500 PSI, or about 0.85 volts on the ICP sensor
4. Fuel Injector Pulse Width (FIPW): Between 1 and 6 milliseconds (0.001 to 0.006 seconds) on the 7.3L .....Between 0.5 ms and 2 ms (with FICM SYNC and SYNC achieved) on the 6.0L

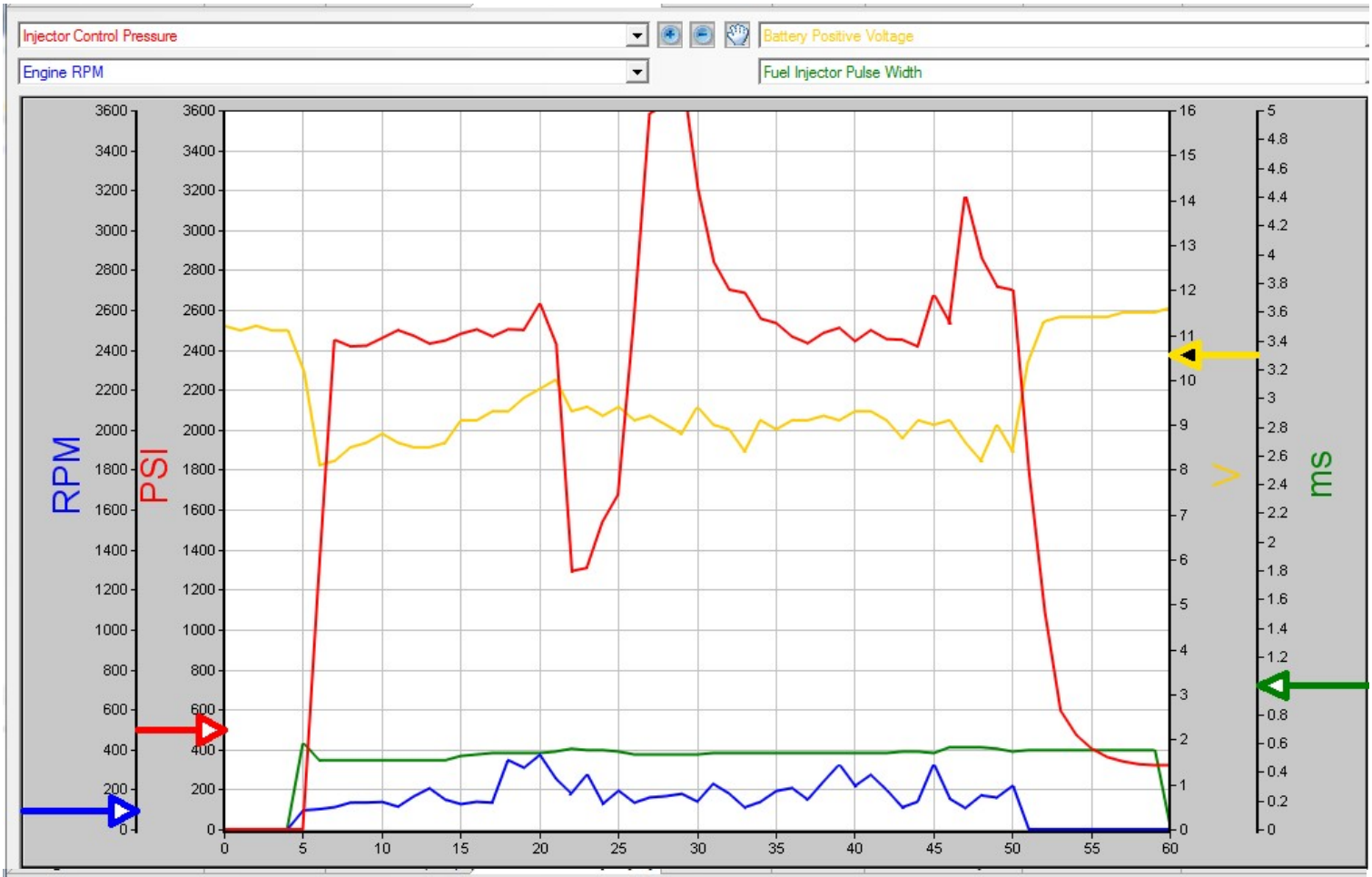
I'm going to be mean and introduce something not in the official list: IPR (Injector control Pressure Regulator). On AE, it's called Injector Control Pressure Duty Cycle. This is a “valve” that *controls* the ICP, so it's frequently helpful to know that the ICP is responding to its *commands*... not just throwing a number at us for the helluvit. IPR will start in about 10% and climb while cranking, then drop to back down when running. The number the IPR settles on is *about* 11%-12% on a properly-working stock truck with a stock tune at full oil temperature (at idle). It should be very stable at idle.

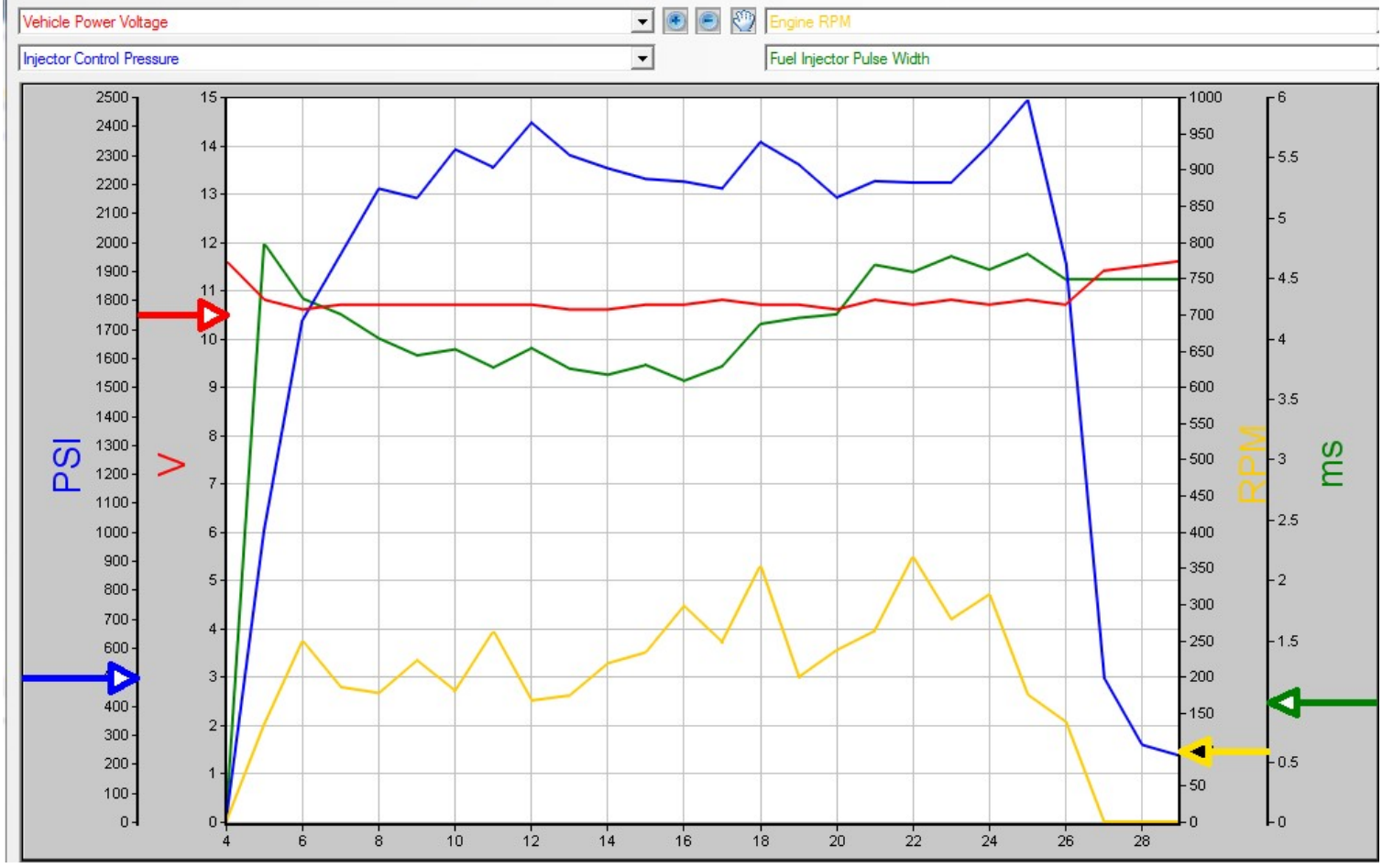
Chapter 12

Three No-Starts

I have some graphs here of trucks cranking but not starting. I put color-coded arrows at the minimums needed for each sensor reading. They all have different problems... two are easy and one is difficult.




Injector Control Pressure
Battery Positive Voltage
Engine RPM
Fuel Injector Pulse Width
RPM
PSI
V
ms


Vehicle Power Voltage
Engine RPM
Injector Control Pressure
Fuel Injector Pulse Width
PSI
V
RPM
ms

Quote:

> Originally Posted by **CampSpringsJohn**
> *If the IDM doesn't have the voltage to fire the injectors, will you still get a pulse width reading?*

The IDM takes the vehicle 12V and "generates" the 115 volts needed to fire the injectors. If the IDM has no power, I'm pretty sure the PCM will freak out and flop around like a carp on the beach when it can't B.S. with his buddy. If the power is there, but the high-power outputs are toasted, the IDM will whine and snivel to the PCM and the PCM will say "Fine. You don't have to fire the damn sticks." and report a very narrow pulse width (under minimum) on the OBDII. This just happened this week. What blew the IDM? Both UVCHs bad... power had nowhere to go but up in smoke.

Quote:

> Originally Posted by **Richard Eckerle**
> *is marginal voltage the problem on the last graph?*

Naw... low voltage wouldn't allow the pulse width to climb. Basically, the last one says it should run, but it's not running. Now we need to visit all the other engine requirements to troubleshoot this one.

- Good fuel?
- Fuel pressure?
- Good air?
- Timing (CPS)? We see the CPS working because we have an RPM signal. There's a DP in there, so I recommended yanking that long enough to get the truck running again.
- Compression? It just had glowplugs replaced... unsure if they were tighteed down properly.
- Glow Plug system? GPR recently replaced, GP LED works, all GPS ohmed out.
- UVCH? All injectors ohmed out. Open circuits trigger a code and there is no code on the truck.

No resolution yet, but we have a checklist.

Chapter 13

A fellow member has an issue with very anemic power.

- The Injector control Pressure Regulator - IPR (Injector Control Pressure Duty Cycle on AE) is a "valve" that controls your Injector Control Pressure - ICP. Remember, the ICP is what pushes the fuel out of the injector, like air pressure pushes beer out of a keg.
- The ICP sensor tells the PCM what the pressure is, the PCM takes all the other sensor data and the *tune* decides if the ICP needs to raise, lower, or or stay pat. Once the tune makes a decision, the PCM tells the IPR what to do.
- The High Pressure Oil Pump responds to the IPR, and the ICP sensor measures the ICP from the pump to tell the PCM what effect the IPR command had.

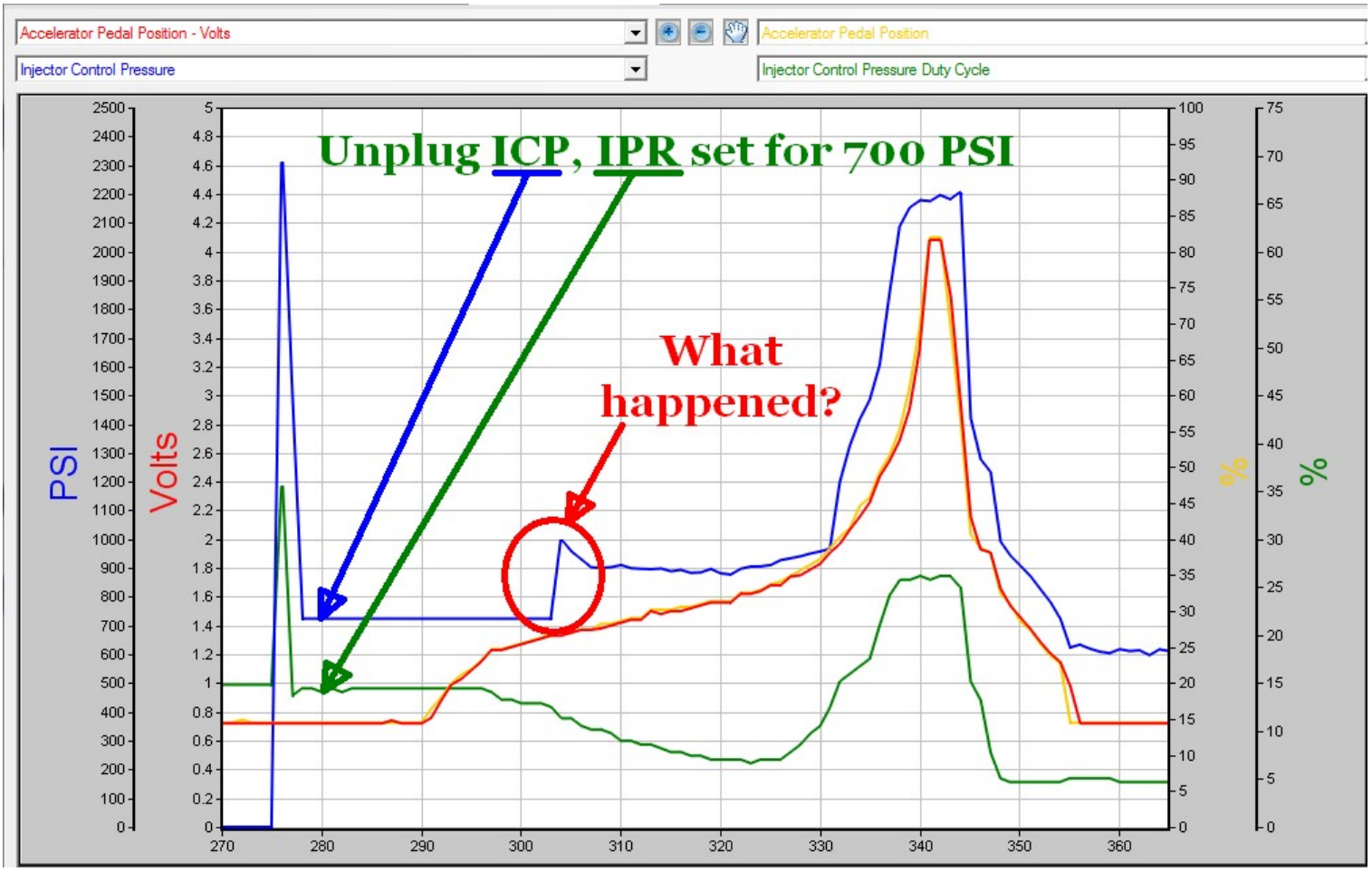
This is a feedback loop.

- Unplug the ICP cable and the stock program sets the IPR to a level where it "expects" the ICP to reach 700 PSI. This allows the engine to run in the event of an ICP sensor failure, but the sauce is substantially subdued (low power when driving).

This is *without* feedback.

In this member's case, his IPR was under 5% at idle... this is really low. I don't it get below 10%, except on tuned trucks with big

nozzles... but I've never seen it *this* low and this is a stock truck. Why would the IPR be so low? I asked him to unplug, then plug in the ICP sensor and I attached the resulting graph so you could take a look at what's going on:



Quote:

> Originally Posted by **Christof13T**
> *Ipr perhaps getting sticky... ?*
> *Or a failing oring that catches pressure again after it has its little fit?*

I strongly suspect the ICP is lying. Remember - *low* power. If the IPR was sticking, the truck would be loud as hell and the throttle would be so touchy that the truck would freak out just showing a *photo* of a foot at the throttle. If the IPR is working properly and the ICP sensor kicks in with *that* - bad ICP... or another alternative: Something could be up with a ground connection somewhere, making the ICP a liar again. More tests are needed before the Buck$Zooka gets dusted off.

Quote:

> Originally Posted by **BWST**
> *Rich, you said you had him unplug the ICP and then plug in. Is the "what happened" circle where he plugged in again? but the throttle starts coming up, then he plugs it in - that's probably not right. Where's the plug back in part on the graph?*

The flat part of the ICP line (700 PSI) is what you would see with an unplugged ICP sensor. I'm lost as to why the *real* ICP signal chose that moment to pop onto the graph... maybe one person was operating the throttle and the other plugging in the sensor. This was all done in neutral in the driveway, we were focusing on the TPS because it did something weird on the road.

Chapter 14

While listening to crickets, I got it into my head I didn't explain that all the way through.

First, we're pulling a sensor connector... then plugging it in with the engine running. We might be seeing a "delay" before the ICP signal pops on the graph.

1. The PCM had no feedback from the ICP sensor, so it set the Injector Pressure Regulator to about 14% at idle. Under normal circumstances on a stock truck, this will put the idle ICP at 700 PSI. (startup is about 2400 ICP, so don't freak when it does this) To explain what's happening, let's say you're reaching for a bottle of water by the night stand... but the lights are out. You know where the bottle *should* be, so that's where you're grabbing.
2. The PCM is happy to blindly keep that IPR at 14%, until the ICP sensor is plugged in. Plug in ICP sensor, PCM sees the ICP, and the PCM adjusts the IPR to fine-tune the ICP. Plugging in the sensor with the engine running is like turning on the lights while you're reaching for the bottle of water on the night stand... you can now fine-tune your targeting.

However! When the ICP sensor came online in this instance, the ICP sensor said the ICP is 1000 PSI, not the 700 the PCM expected. One could say "Oh look, my pressure is too high" and that's exactly what the PCM said to itself as it lowered the IPR to compensate. The driver is complaining of *weak* throttle response and too much ICP won't cause that... but turning the pressure down *below* normal WILL. This suggests the PCM was guessing *correctly*while the ICP was unplugged, but the PCM is going the wrong way now... based on the feedback from the ICP (which appears to be lying). The ICP did the equivalent of putting a series of mirrors in *front* of your bottle of water before turning on the light. You now see the bottle in a different location than where you though it should be... so you're grabbing wildly and your efforts will never satisfy your thirst.

For those with a scan tool, do you want to know right now today if you have a good ICP? A cold stock engine runs ICP about 700 PSI at idle, and it slowly drops until it reaches about 480 PSI at idle when warm. Unplug the ICP connector with a warm truck running while you watch ICP and IPR (ICP Duty Cycle). On a stock truck - if plugging in the ICP shows about 700 PSI and the IPR starts to gently change that number to about 480 PSI and an IPR about 11.3%... all good. If plugging in the ICP shows a radically different number than 700 PSI (I'll get a solid number later) and the IPR makes a dramatic change to correct the pressure, don't load a money clip into the Buck$Zooka just yet... this warrants more investigation.

Man... I just read the post above again and I realize this is a tough one to simplify, yet explain it completely. Paring it to the bone:

1. Unplug ICP sensor on a running warm engine and AE says IPR is about 14%, with ICP 700 PSI.
2. Plug ICP sensor back in and IPR should drop to about 11% and ICP about 480 PSI at idle on a stock truck.

If you see anything different than that, ask questions.

Chapter 15

MPG

I mentioned this in an obscure thread and I thought it was worth mentioning here. I have seen a few members with OBDII devices that monitor the truck as they drive and I noticed they focus on things like transmission temp, ICP, and FIPW. If you have the ability to monitor just two items on a scan gauge, transmission temp is a good one, to be sure... but there is a "biggy" in there that gets overlooked: Mass Fuel Desired (MFD). This is the PCMs interpretation of exactly how much fuel you need to get the job done (even with cruise control active) at any given moment. By itself, the number is pretty fickle... but couple it with your speed, gear, and situation and you have an MPG meter. If you are cruising at a set speed in OD on the flat with no wind, you can memorize that number for future reference.

Example: I drive at 65 MPH every day on the same stretch of road, and I have plenty of flat stretches of road. I'm custom-tuned with

big sticks, so *my* MFD isn't likely to match everybody else's, but I know my MFD number at 65 MPH on the flat with no wind. Say I have a hypothetical MFD of 22. If the number climbs to 24 in a headwind, I know I've lost about 10% fuel economy on that stretch of road. If I tow, that number will climb and I can see what kind of hit I'll take at the pump... before the gauge has a chance to move! Say you do a mod or repair after you know your MFD number... you'll know the effect on your MPG right freaking now - not 300, 400, or 500 miles later. Remember: The gear you're in, speed, wind, hills, and other loads change the meaning of the number - so you need to compare the number under identical circumstances.

Chapter 16

High EGTs and lower boost.

As everybody knows, there are many causes of this and the first assumption is usually a boost or exhaust leak. AE can be used to *help* troubleshoot this problem, but like everything else with AE... it's not going to just tell you "Well *there's* your problem!". You now need to investigate the *why* of a reading. Here's a scenario I just went through:

I was climbing a mountain pass, like I have done *many* times before. My EGTs were higher than they usually are on the same grade, so I immediately went into troubleshooting mode. My AE was showing a lower Exhaust Back Pressure reading than I expected by about 10%. My boost was down about the same amount. One person might grab the boost leak detector and have at it, after they went crawling under and over the engine on sound and soot safari. *I* started with the simple stuff... the filter minder. Yup... it's time. Some might say "But Tugly, a clogged filter should *raise* backpressure.". Nope. Block a shop vac hose with your hand and listen to the motor... it spins *up*! There is more vacuum, meaning the air in the turbine is a much lower density... reducing the load on the motor. Put that same theory on our beast and there is less density on the compressor side of the turbo (vacuum), so the exhaust pushes the turbine more easily... reducing backpressure.

It's easy to get intimidated by the complexity of our beasts, I've been guilty of that many times. As I learn more, many woes on the forum keep coming back to the first thing I learned in a diesel class I attended at the dealership: Plenty of clean fuel, clean oil, and clean *air*.

Chapter 17

Quote:

Originally Posted by **BWST**

I see the EBP sensor is still reading almost 2psi high. I had cleaned the sensor and tube, both full of carbon. Guess the sensor did not recover. Should I go ahead and replace it?

Is there a way to have the BARO show up in psi instead of volts?

It needs replacement only if that reading above is KOEO. That differential is equal to the driving pressure of about 45 MPH on the flat at your altitude. It's not a rush, but I would replace it before towing or hauling. That 2 PSI isn't the scary part... the fact that it's lying is.

AE does not convert the BARO voltage to absolute PSI, but Infinity and maybe a few other scan tools/OBDII gauges do. I can tell you that's the same Baro reading I got in your area. I had a chart around here somewhere that converted voltage to PSI, but I can't find it. I *did* find a little gem in my search, though.

Chapter 18

Quote:

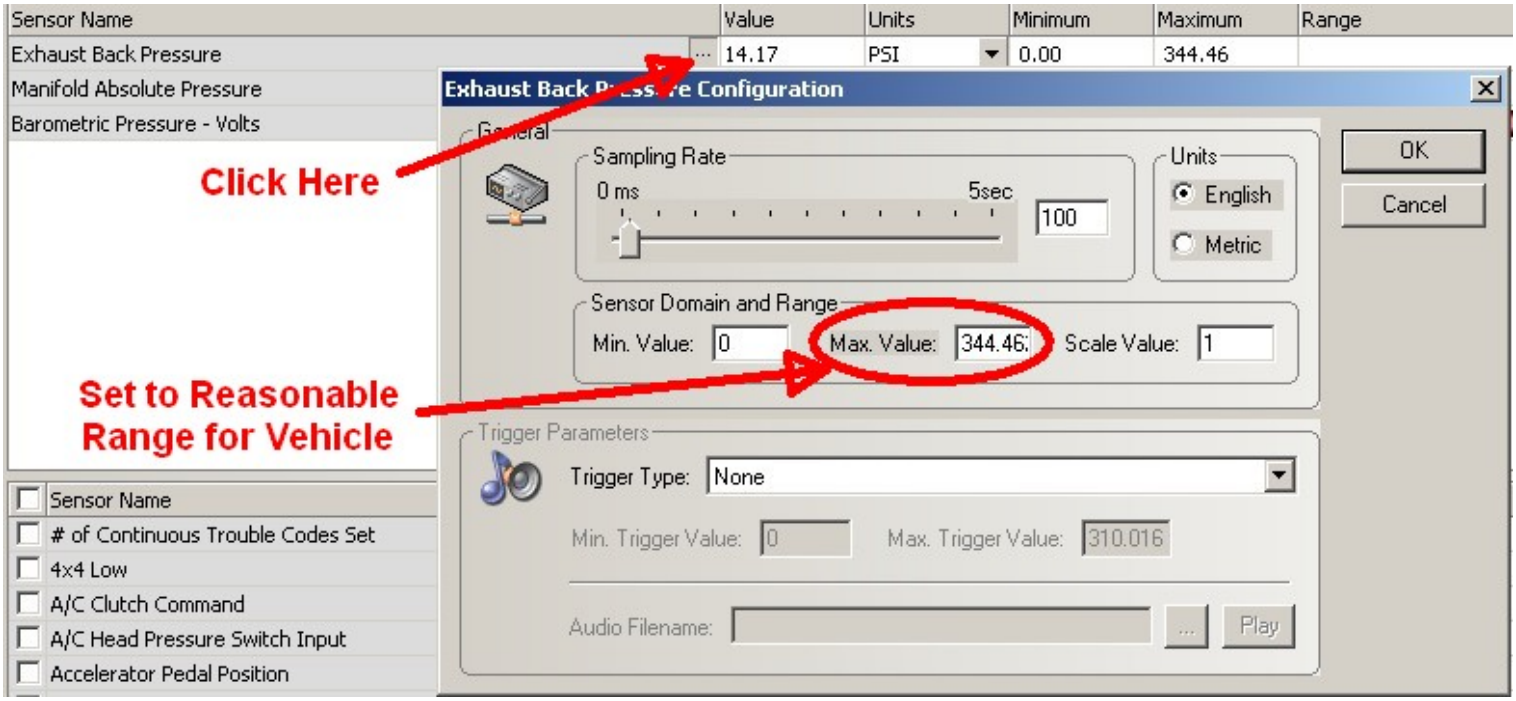
> Originally Posted by **BWST**
> *Question: Is there a KOEO test that checks relays, sensors and such and reports back? All I've done so far is just pull up nine meters on the Live Data Meter tab. I've set up a Cyl rot velocity session and a "basic" session with nine meters like the ones above.*
>
> *What do the colors mean? Most are green, but some meters come up yellow and red.*

Look up. You are on the "Live Data Meter" tab. You want the "Test Onboard System" tab.

Colors: *Great* question. From the Scan Tool User Guide that came with the software:

Meters will report the current status of the sensor through color cues. If the sensor is functioning at 80 - 90% of its capacity, the meter will change its color to yellow. If the sensor is between 90 - 100%, the meter will change to red. Below 80%, the meter will dis-play in green.

"Capacity" - This is another word for "Maximum"... determined by the Max Value you set here (in relation to the Min Value):



Now... to play with it, let's say you want the IPR to turn yellow at 30%. You can set the Max to 38% and the IPR will turn yellow at about 30% (getting on the throttle) and red at about 34 %, but graphing gets a little more involved if you want to see an IPR value graphed over 38% during playback (the value gets recorded even if it's over Max... I think).